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U. S. Department of Agriculture

**REPORT OF  
THE  
CHIEF OF THE  
BUREAU OF  
BIOLOGICAL  
SURVEY  
•  
1937**



# REPORT OF THE CHIEF OF THE BUREAU OF BIOLOGICAL SURVEY, 1937

UNITED STATES DEPARTMENT OF AGRICULTURE,  
BUREAU OF BIOLOGICAL SURVEY,  
Washington, D. C., September 15, 1937.

Hon. HENRY A. WALLACE,  
*Secretary of Agriculture.*

DEAR MR. SECRETARY: I present herewith the report of the Bureau of Biological Survey for the fiscal year ended June 30, 1937.

Sincerely yours,

IRA N. GABRIELSON, *Chief.*

## CONTENTS

|                                                  | Page |                                                                   | Page |
|--------------------------------------------------|------|-------------------------------------------------------------------|------|
| Introduction.....                                | 1    | Migratory-waterfowl restoration program.....                      | 31   |
| The chief program of the year.....               | 1    | Refuge restoration and development.....                           | 31   |
| Outstanding events.....                          | 3    | Habitat reconnaissance and improvement.....                       | 35   |
| Keeping the public informed.....                 | 5    | Easement refuges.....                                             | 36   |
| Funds available to the Survey.....               | 5    | Providing for maintenance and patrol.....                         | 37   |
| Organization of the Bureau.....                  | 5    | Administration of national wildlife refuges.....                  | 38   |
| Research on wildlife status and management.....  | 6    | Bird refuges.....                                                 | 38   |
| Status of waterfowl.....                         | 6    | Big-game preserves.....                                           | 45   |
| Research on forest and range fauna.....          | 8    | Wildlife conservation laws administered.....                      | 51   |
| Biological research on refuge areas.....         | 9    | Regulatory action.....                                            | 51   |
| Wildlife-management research.....                | 9    | Work of game-management agents.....                               | 52   |
| Biological investigations in Alaska.....         | 12   | Violations and penalties imposed.....                             | 53   |
| Banding game and other birds.....                | 12   | Court action on the baiting regulation.....                       | 55   |
| Records of bird distribution.....                | 13   | Wildlife conservation in Alaska.....                              | 55   |
| State surveys and reports.....                   | 14   | Importation and other permits issued.....                         | 56   |
| Economic studies of wildlife.....                | 14   | Foreign species excluded.....                                     | 56   |
| Waterfowl food investigations.....               | 17   | Species entered under permit.....                                 | 57   |
| Mosquito control in wildlife habitat.....        | 18   | Permits under the Migratory Bird Treaty Act.....                  | 58   |
| Laboratory research in food habits.....          | 19   | Permits for special uses of refuges.....                          | 59   |
| Cooperative food-habits research.....            | 20   | Cooperative control of predatory and other injurious animals..... | 59   |
| Field investigations of injurious species.....   | 21   | Predatory animals.....                                            | 59   |
| Fur-animal conservation and restoration.....     | 21   | Rodent control.....                                               | 60   |
| Interest in fur resources international.....     | 22   | Supply depot and laboratory.....                                  | 62   |
| Demand for information increasing.....           | 22   | Control methods research.....                                     | 62   |
| Progress in fur farming.....                     | 23   | Lethal doses for bait material.....                               | 62   |
| Research in cooperation with other agencies..... | 23   | Burrow fumigants.....                                             | 62   |
| Fur Animal Experiment Station.....               | 24   | Orchard-mouse control.....                                        | 63   |
| Rabbit Experiment Station.....                   | 24   | Improved rat baits.....                                           | 63   |
| Wildlife disease control.....                    | 26   | Rodents and range and forest regeneration.....                    | 63   |
| Relationship of domestic stock and wildlife..... | 26   | Coyote migration.....                                             | 63   |
| Pollution problems.....                          | 26   |                                                                   |      |
| Diseases of fur animals.....                     | 26   |                                                                   |      |
| Acquisition of lands for refuges.....            | 27   |                                                                   |      |

## INTRODUCTION

### THE CHIEF PROGRAM OF THE YEAR

With the formulation of the national wildlife program that inspired conservationists in 1935 and 1936, a program with objectives that approached the ideal more closely than had been found practicable in any that preceded it, the Bureau of Biological Survey has settled down to the more matter-of-fact but equally essential task of carrying out the details. It is this sort of activity that has characterized the work of the year—this and the continuing development of attitudes and plans to provide greater and broader cooperation for the restoration and conservation of the Nation's wildlife resources.

As waterfowl management is fundamentally dependent upon the availability of breeding stocks, it is incumbent upon the individual sportsman, organizations interested in wildlife, and the local, the State, and the Federal Governments, each in its peculiar field, to carry out its own obligations in effecting the return of birds to the nesting grounds. It is now gratifying to report that with the educational and informational work that has been undertaken over many years, including that of the Biological Survey, this responsibility is being taken more and more seriously: there is increasing cooperation between Federal and State Governments, and there is ever more manifest among sportsmen a willingness to support and abide by regulations restricting former liberal hunting privileges. There is also a growing appreciation of the fact that unless hunters exercise self-restraint in the kill of migratory game, there will be no birds to occupy the refuges now being acquired and improved under a \$21,000,000 program and the plans for the restoration and rehabilitation of this great resource will be fruitless.

The conservation gains thus attained since the inception of the waterfowl-restoration program are now being consolidated. The farsightedness that resulted in the provision of funds for beginning the execution of the Survey's waterfowl recommendations over many years brought forth numerous diverse and widely scattered proposals for refuge restoration. The original plans are being carefully scrutinized, and through careful research the chief efforts are now devoted to a distribution of refuges that will benefit all sections of the country and all species of wildlife.

Less spectacular than the engineering works for the restoration of water areas, than the flights of increasing numbers of wild fowl to the reestablished lakes and marshes on their ancestral breeding grounds, is the underlying research. This research, as instituted by the Bureau more than half a century ago is being expanded to cover the new conditions brought about by the inception of the restoration program. Although the chief emphasis has been on the successful prosecution of this program, there has been no relaxation in other directions. Research has been vigorously pursued affecting nonmigratory game and nongame species, their distribution and abundance in the wild, their economic status, and their susceptibility to propagation and perpetuation under controlled conditions, as on fur farms, game preserves, and elsewhere.

Many who live in favored sections, in which waterfowl will always be found so long as any remain on the continent, still ask the Bureau for more liberal hunting privileges, either from purely selfish motives or through an incomplete understanding of the calamitous conditions in other parts, particularly on far-distant breeding grounds that produce under highly adverse conditions the very birds they wish to shoot. To illustrate, except for small numbers of a few species, the middle Atlantic seaboard does not produce the waterfowl locally hunted. Rather, many species come from the great prairie sloughs of the North Central States and Canada, so that improvement of local breeding grounds only cannot increase the supply of the birds sufficiently to meet the hunters' requirements. In such areas the only possible local help is to limit the kill while the rehabilitation of breeding grounds is going on and serious efforts are being made to restock the restored refuges.

Hunting regulations are irksome, as are most restraints on individual initiative, and it is no pleasant task for the Biological Survey to impose restrictions on the use of a national resource that was traditionally available to all citizens from the time of the discovery and early settlement of the country up to a generation ago. When the dwindling of this resource began to be felt, it was then almost too late to remedy the situation. Even conservation officials shared the rather general opinion that there was no hope for the waterfowl and that, as they seemed destined to go anyway, the season might just as well be opened wide to allow duck hunting 12 months in the year—on the nesting grounds, on the spring migration routes, and anywhere else.

If the old hopeless condition still prevailed many would feel exactly the same way about it now, but it has undergone a change. During the last 3 years, since the Biological Survey has for the first time been enabled to do constructive work on a scale large enough to give real hope for the future, more than \$20,000,000 has been available for the purchase and development of refuges, including restoration of water levels, providing better feeding, breeding, and wintering grounds, and fencing and posting areas acquired. The program is simple and biologically sound but by no means completed. Its success depends upon many factors, some of which are outside the control of those handling the work.

In the first place, if there are to continue to be ducks and geese in this country, they must have suitable habitat in which to breed, feed, and rest—in other words, marshy areas in localities favorable for the birds must be increased rather than further drained. In the second place, adequate breeding stock must be returned to these marshes and to the far greater nesting areas of Canada.

The knowledge that waterfowl follow four main flyways in traveling twice a year between breeding and wintering grounds has influenced the selection of sites for refuges. Surveys show that there are in this country approximately 7,500,000 acres of marshland well situated along these flyways that can be restored to constitute the framework of an adequate refuge system. To supplement these major areas, the Bureau is endeavoring to restore by local cooperation every available acre of marsh within the natural breeding grounds of the birds.

The habitat-restoration work is usually in places not readily accessible to great numbers of people, and thus much of it is not seen, which is just as well, because successful nesting demands seclusion. The waterfowl breeding grounds within our continental territory are largely in the northern tier of States west of the Great Lakes, a region that experienced a great calamity when changed by the drainage movement that swept the country in the last century. Both Federal and State Governments wish to put water back in many of the drained ponds and marshes. Up to the present time the Biological Survey has acquired or optioned, or has had reserved by Executive order, more than 2,000,000 acres on which restoration measures and improvements for wild fowl are now being undertaken. Examples of nesting-ground restoration are given in later pages of this report. When present funds are exhausted the program will have reached nearly the halfway mark. The completion of the work depends to a large extent upon the support the program receives from the sportsmen of the country. The constructive work of refuge rehabilitation is interesting and fascinating. Restrictive measures applied to such outdoor recreation as waterfowl hunting, though never popular, are necessary.

There is no magic way to restock the new and former breeding areas. Either an increasing number of birds must be allowed to return to them each spring or the sport of duck hunting will vanish. The necessity for severe restrictions on hunting has not passed.

As intimated in the report a year ago, for the first time in 10 years or more, a slightly increased breeding stock returned northward in 1936. That meant that the drastic restrictions of 1935 reduced the losses among the birds to less than the number that were produced the previous spring. It is encouraging to report that continuation of the restrictions during the 1936 season and the cooperation of sportsmen had a similar result: the number of birds returning to the breeding grounds in 1937 exceeded the number of 1936. These facts were ascertained on the breeding grounds by Survey representatives who have checked certain definite areas during many seasons.

#### OUTSTANDING EVENTS

Events that marked the past year's work of the Biological Survey may be briefly noted as follows, the details being given on subsequent pages:

#### WILDLIFE RESEARCH

*Research centers.*—Assignment of the first permanent research worker to the Wichita Mountains Wildlife Refuge (Okla.) and near completion of a wildlife laboratory there; and establishment and planning the development of the Patuxent Research Refuge (Md.).

*Reestablishing musk oxen.*—Safe transfer of the remaining 27 animals in the musk ox herd to Nunivak Island from the Experiment Station at Fairbanks, Alaska.

*January waterfowl inventory.*—Confirmation of earlier conclusions that ducks and geese are slowly increasing in numbers, by cooperative surveys of waterfowl-concentration areas of the United States by an army of fully 2,000 biologists, game-management agents, pilots of water and air craft, and other personnel.

*Investigations in Mexico.*—Reports by two field parties that despite limited market shooting, migratory waterfowl probably enjoy greater security during their sojourn in eastern and western Mexico than elsewhere on the continent.

*Mosquito-control studies.*—Injury to wildlife checked by persistent surveillance of Federal, State, and municipal drainage and mosquito-control projects.

*Predation on waterfowl.*—Completion of waterfowl-nesting studies in two contrasting areas, from which it is indicated that the emphasis on predation changes from year to year, crows being locally responsible for nestling mortality at one time and skunks, weasels, foxes, or other predators at others.

*Food of coyote.*—Completion of a 6-year stomach-analysis study of the food of the coyote in relation to livestock and wildlife, as a basis for formulating control policies.

*Rabbit experiments.*—Determination by cooperative experimental hat manufacture of the relative felting qualities of wild cottontail and jack rabbit pelts; and demonstration of the value of the self-feeder, whereby whole grains are utilized and feed costs lessened, almost revolutionizing domestic rabbit-feeding practices.

*Sex in fox-pelt values.*—Through study of receipts from auction sales of some 10,000 silver fox skins, demonstration that pelts of males, both pups and adults, brought higher prices than those of females.

*Quail diseases.*—More prompt diagnosis and eradication of epizootics on game farms made possible by study of protozoan infections in bobwhite quail.

*Deer and tick fever.*—Demonstration that deer in Florida are hosts of the tropical variety of the fever tick.

#### NATIONAL WILDLIFE REFUGES

*Refuge lands purchased.*—Approval or consummation of negotiations for the acquisition of 134,655 acres of waterfowl refuge lands at an average cost of \$10.46 an acre, bringing the total of national wildlife refuge lands purchased since July 1, 1933, to 1,558,298 acres, at an average cost of \$6.50 an acre.

*Refuges reserved by the President.*—Establishment by Executive orders of 11 national wildlife refuges, aggregating 1,874,300 acres in 7 States, primarily for the protection and preservation of resident game species, bringing the total thus reserved in 4 years to 4,037,470 acres in 17 refuges.

*Refuge surveys.*—Surveying, monumenting, posting, and mapping 295,900 acres in 57 national wildlife refuges, as prerequisites to adequate administration.

*Acquisition expenditures.*—Expenditure of \$1,123,051 in acquiring new refuges for migratory birds, purchasing areas previously optioned, and completing purchases of lands within the boundaries of older refuges.

*Extension of easement-refuge program.*—Extension into Montana of the easement-refuge program of migratory-waterfowl restoration, begun in North Dakota last year, bringing the number of projects completed or under construction to 75 and the acreage to 118,777.

*W. P. A. cooperation.*—Allotments totaling \$1,628,926 made by the Works Progress Administration for developing refuges in 10 States.

*N. Y. A. assistance.*—Through cooperation on the part of the National Youth Administration, the employment of several hundred young men in making waterfowl observations, food and cover plantings, and nesting studies on migratory-bird refuges.

*Refuge development by C. C. C.*—Refuge development by Civilian Conservation Corps enrollees extended to 28 waterfowl refuges and big-game preserves, primarily in building up essential water resources and food and cover growth.

*Refuge utilization.*—An estimated threefold to fivefold increase since the inception of the emergency program in 1934 of the wildlife populations on the Bureau's migratory-bird refuges.

#### LEGISLATION AND REGULATION

*Mexican treaty.*—Exchange of ratifications and proclamation on March 15, 1937, of a Convention between the United States and the United Mexican States for protecting migratory birds and regulating shipments of game mammals between the two countries.

*Hunting regulations.*—Providing protection by close seasons for brant on Atlantic coast and for redhead and canvasback ducks.

*Law enforcement.*—Successful prosecution for conspiracy to violate the Lacey Act of persons illegally handling furs, and continuance of the drive against duck bootleggers and persons taking waterfowl by means of bait.

## PREDATOR AND RODENT CONTROL

*Predators in Alaska.*—Resumption of predatory-animal control in Alaska to demonstrate methods to resident trappers and to aid them in obtaining necessary equipment.

*Control of rodents.*—Under Bureau supervision reduction of rodents on 34,652,418 acres for the protection of farm crops, range grasses, silvicultural plantings, and reclamation waterways and the conservation of surface soils; and development of improved orchard-mouse baits and field practices in New England.

*Hawaiian rat control.*—Establishment of a control-methods laboratory and bait-production plant in Honolulu for experiments in rat control and for the manufacture and canning of baits for distribution to island plantations.

## KEEPING THE PUBLIC INFORMED

To present currently the results of its research and other activities, the Biological Survey contributes to the several series of publications of the Department and issues, chiefly for use in replying to correspondence, a mimeographed series of Wildlife Research and Management Leaflets, references to certain numbers of which are made under appropriate headings in this report. The Bureau on occasion has issued statements for the press, through which interested groups are currently informed on its activities, and has participated through its public-relations and other technical staff in radio programs. To promote visual information on its work for wildlife, the Survey has participated in exhibits, cooperated in motion-picture production, and contributed film strips to the Department's series with accompanying outlines for lectures. Through members of its technical staff the Bureau has been represented during the year at numerous gatherings of ornithologists, mammalogists, conservationists, sportsmen, wildlife managers, fur farmers, stockmen, and others interested in the protection, propagation, utilization, and control of the Nation's valuable resources in wild-animal life and has thus had opportunity to present in greater detail and to special groups such information as is summarized in this report. Two of its published contributions, combining the programs and subject matter of several projects, may here be noted: Wildlife in Land Planning (Leaflet BS-71) and Game Management on the Farm (Farmers Bulletin No. 1759). Of the latter 90,000 copies were printed, two-thirds of which were distributed before the end of the fiscal year.

## FUNDS AVAILABLE TO THE SURVEY

From regular and emergency appropriations a total of approximately \$6,030,000 was available for the work of the Survey for the year. Of this sum \$1,836,224 was carried in the Agricultural Appropriation Act for regular activities; an estimated total of \$600,000 has been collected from sales of Federal migratory-bird hunting stamps; and \$12,340 was allocated to the Bureau from the Bankhead-Jones special research fund for an economic study of wildlife management as a supplementary farm enterprise. The sum of \$40,000 was allotted from the Emergency Relief Appropriation Act of 1935 to complete work carried on in North Dakota on the development of waterfowl refuges, and \$6,100 for resulting administrative expenses. A total of \$1,588,926 was assigned from the Emergency Relief Appropriation Act of 1936 to conserve water and wildlife, to check floods and erosion, to increase fur production, to provide stable water supplies, and to create Federal waterfowl refuges in North Dakota, South Dakota, Montana, Nebraska, Louisiana, Oklahoma, Wisconsin, Wyoming, and Michigan and \$47,500 for administrative expenses. For expenditures in connection with work performed by the C. C. C. on national wildlife refuges, a total of approximately \$1,900,000 was made available to the Bureau.

## ORGANIZATION OF THE BUREAU

To bring about more efficient administration, including coordination of activities and expedition of work, and to engender a group spirit and solidarity, plans for a reorganization of the Survey's field services were completed to become effective July 15, 1937. With the exception of research functions, regulation of importations of foreign wildlife forms, and land-acquisition work, all field activities will be placed under a regional organization. The 10 regional directors are subject to instructions directly from the Chief of Bureau and the

heads of divisions and sections in Washington. The present organization, with officials in charge, is as follows:

|                                                                     |                        |
|---------------------------------------------------------------------|------------------------|
| Chief of Bureau                                                     | Ira N. Gabrielson      |
| Associate Chief                                                     | W. C. Henderson        |
| Technical adviser and research specialist                           | W. L. McAtee           |
| Division of Administration                                          | W. R. Dillon           |
| Assistant                                                           | Thos. E. Jacoby        |
| Section of Personnel and Pay Rolls                                  | E. J. Thompson         |
| Section of Accounting                                               | S. C. Moore            |
| Section of Purchases and Property                                   | J. L. Talbert          |
| Section of Mails and Files                                          | W. D. Hobbs            |
| Division of Public Relations                                        | H. P. Sheldon          |
| Assistant, in charge of Editorial Section                           | Wm. H. Cheesman        |
| Section of Current and Visual Information                           | Howard Zahniser        |
| Division of Wildlife Research                                       | W. B. Bell             |
| Section of Wildlife Surveys                                         | H. H. T. Jackson       |
| Section of Distribution and Migration of Birds                      | F. C. Lincoln          |
| Section of Food Habits                                              | Clarence Cottam        |
| Section of Fur Resources                                            | Frank G. Ashbrook      |
| Section of Disease Control                                          | J. E. Shillinger       |
| Division of Land Acquisition                                        | Rudolph Diefenbach     |
| Section of Appraisals and Negotiations                              | R. M. Rutherford       |
| Section of Surveys and Maps                                         | A. A. Riemer           |
| Division of Migratory Waterfowl                                     | J. C. Salyer, II       |
| Assistant, in charge of Section of Maintenance and Patrol           | A. C. Elmer            |
| Section of Reconnaissance and Habitat Improvement                   | W. F. Kubichek         |
| Section of Restoration and Development                              | Amos B. Emery          |
| Division of Game Management                                         | Stanley P. Young       |
| Assistant, in charge of Section of Big Game Refuges and Game Agents | W. E. Crouch           |
| Section of Law Enforcement                                          | F. P. Callaghan        |
| Section of Importations and Permits                                 | R. W. Williams         |
| Section of Predator and Rodent Control                              | A. M. Day              |
| Regional directors (with headquarters):                             |                        |
| Region 1 (Pacific), Portland, Oreg.                                 | Wm. M. Rush            |
| Region 2 (Mountain), Denver, Colo.                                  | Leo L. Laythe          |
| Region 3 (Southwestern), Albuquerque, N. Mex.                       | Donald A. Gilchrist    |
| Region 4 (West Central), Des Moines, Iowa                           | George Tonkin          |
| Region 5 (Southern), State College, Miss.                           | Roy Moore              |
| Region 6 (East Central), Milwaukee, Wis.                            | Daniel H. Janzen       |
| Region 7 (Southeastern), Atlanta, Ga.                               | James Silver           |
| Region 8 (Northeastern), Portland, Maine                            | Bertrand E. Smith      |
| Region 9 (Plains), Omaha, Nebr.                                     | Burnie Maurek (acting) |
| Region 10 (Alaska), Juneau, Alaska                                  | Frank Dufresne         |

#### VETERAN WORKERS RETIRED

Three veteran workers of the Bureau were retired during the year: Theo. H. Scheffer was retired on February 28 after 27 years in scientific and control work in Washington, D. C., and in the field, during which he was the author of Farmers' Bulletins and other publications on moles, pocket gophers, mountain beavers, and the crested myna. Harry H. French, after 32 years' service in the Department, which began in the Forest Service in 1905, was retired on January 31 as superintendent of the Wichita Mountains (Okla.) Wildlife Refuge, with which he had been connected since 1926, during the earlier years as Forest Service supervisor. Ethel N. Jett, who began work in 1908, also with the Forest Service, was retired on January 31 after 17 years' service with the Survey, during the last part of which she was custodian of the Bureau's photograph files.

## RESEARCH ON WILDLIFE STATUS AND MANAGEMENT

### STATUS OF WATERFOWL

#### SURVEYS IN CANADA

At the beginning of the year four field parties of biologists were making waterfowl observations on the southern Canadian breeding grounds, one in British Columbia, the second in Alberta and western Saskatchewan, the third in eastern Saskatchewan and Manitoba, and the fourth in Nova Scotia and New Brunswick, and a fifth party worked north through the Mackenzie River Valley to its vast Arctic-coast delta. All observers were guarded in voicing optimism on the results of their work, but the leaders were in agreement in supporting the opinion of the previous year that the decline of most species had been stopped.

Breeding-ground observations were resumed during the spring of 1937, and at the close of June all four of the Bureau's flyway biologists, including two recently appointed for the Atlantic and Central flyways, and one party made

up of two experienced game-management agents, were still in the field, in most cases on the identical areas surveyed in past years. The northeastern party made a short reconnaissance of Newfoundland, which included, through cooperation of Newfoundland officials, an aerial survey without expense to this Bureau. All parties report almost weekly by mail or telegraph, but final reports will not be at hand until early fall.

#### INVESTIGATIONS IN MEXICO

Two field parties of biologists were sent in December to investigate waterfowl conditions south of the Rio Grande, one on the lakes, marshes, and lagoons of the western parts of Mexico, the other in the east. A third party was given a short assignment in the Valley of Mexico. The western operations were extended south to Acapulco, and the eastern to the Laguna de Tamiahua, south of Tampico. Most of the larger lakes and lagoons known to be important wintering areas were visited and their waterfowl populations carefully checked. The eastern party, while in the Laguna Madre section of Texas, saw a raft of redheads, conservatively estimated at about 100,000 birds, or more than the combined reports on the species from all other areas.

Despite the notion entertained by many sportsmen that waterfowl are slaughtered in large numbers in Mexico by the use of armadas and other wholesale destructive devices, the birds appear to be safer in that country than in any other part of the North American Continent. Some marketing of wild fowl was found, but the number of birds so taken throughout all of Mexico is far less than the slaughter by sportsmen in any one of our important waterfowl States. The use of armadas (batteries of guns) has now been prohibited by the Mexican Government. Some Mexican areas used by waterfowl have suffered from drainage, but in general, conditions for the winter sojourn of the birds in that country are highly favorable.

#### JANUARY INVENTORY IN THE UNITED STATES

As the culmination of the year's investigations on the status of waterfowl, a January inventory was planned and executed under the direction of the Bureau's regional officers, so as greatly to increase the coverage. The disastrous Ohio-Mississippi flood violently disrupted plans for region 5 (southern), but throughout the season the regional director and his agents had maintained such close touch with the waterfowl situation that the status of the birds was known with a fair degree of accuracy before they were dispersed over thousands of square miles of flooded bottom land.

A large part of the field personnel of the Bureau was assigned to this work, and these forces were augmented by State police and conservation officers, members of the Forest Service, Soil Conservation Service, Bureau of Agricultural Engineering, C. C. C. camps, State agricultural colleges and universities, and others. Patrol boats and other watercraft were supplied by the States, by the Bureau of Marine Inspection and Navigation, and by the Coast Guard. Aircraft were furnished by the Army Air Corps, the Naval Air Service, the Coast Guard, a commercial tire and rubber company, and a few private individuals. In region 7 (southeastern), the regional director had 18 seaplanes and blimps and 1 autogiro at his disposal. Three naval blimps from Lakehurst, N. J., were used in region 8 (northeastern), while in region 5 one naval bomber made a flight of 1,700 miles across the Gulf from Pensacola, Fla., to the mouth of the Sabine River, Tex. In some of the snowbound interior districts the observers carried out their assignments with a fine spirit of cooperation by the use of snowshoes.

#### MIGRATION OBSERVATIONS BY COOPERATORS

Reports on the status of waterfowl within the United States were received from 655 cooperating observers for the fall migration of 1936, and from 594 of these volunteers for the spring of 1937. Their tabulations and analyses fully substantiated the reports of the official staff upon studies in 1936 on the breeding grounds.

#### SUMMARY OF REPORTS

The reports are in substantial agreement that the mallard, black duck, pintail, baldpate, Canada goose, and blue goose are the species now in the most satisfactory condition, and that the menaced goldeneye is steadily increasing.

The status of the other diving ducks continues unsatisfactory, and although the canvasback made notable gains it is still necessary to give complete protection to the redhead, the canvasback, and the ruddy duck. The findings from the investigations on the status of waterfowl are basic considerations in the adoption of regulations placing restrictions on hunting. They were given in some detail in a mimeographed leaflet (BS-88) issued in May.

#### RESEARCH ON FOREST AND RANGE FAUNA

Progress was made during the year in cooperation with the Forest Service in research on the relationships of wildlife to forestry, grazing, and other land use.

At the Harrison Experimental Forest, in Mississippi, particular attention has been devoted to birds in relation to the destruction of longleaf pine seed. Observations and check experiments show that during a year of low seed production birds are not attracted to the area affected and that they are not apt to destroy planted seed. Research also has been conducted on the distribution and relative abundance of rodents, on comparison of late fall and early spring plantings in relation to destruction of pine seed by birds and mammals, and on the distribution and population of birds and mammals in the Gulf States.

Research temporarily suspended at the Lake States Forest Experiment Station was renewed in September, and studies were resumed on the relation of rodents and rabbits to forest plantings. Investigations of the status and food habits of white-tailed deer, and their effect on the forests, and studies of management of winter feeding yards of deer have shown that it is not always so much general lack of cover or food that makes winter conditions critical for deer as it is the inadequate distribution of these necessities. Forested winter concentration areas need more openings provided with browse, and the open burns, logged lands, and brush areas are in need of cover to attract deer from the food-depleted "yards." Some advance also has been made at the Lake States station in a long-time study of the beaver, particularly as to its food and water requirements, and in developing methods for determining the carrying capacity of the environment for these mammals.

At the California Forest Experiment Station a study of the relationship of wildlife to the regeneration of pine forests is a major project. On cut-over areas in the sugar pine-fir type, sugar pine is not restocking as desired, reproduction being largely to white fir and incense cedar. Rodents, by their response to habitat changes following cutting and by their food preferences, play an important part in the regeneration of certain species of trees. Damage by rabbits to seedlings planted during the fall of 1934 at Big Springs brushlands was approximately 40 percent to Jeffrey pine and 60 percent to ponderosa pine. Studies have been made at this station of the effect of burns on animal life and forest renewal. Research has continued on wildlife in relation to the range and to forage production, and on animal-plant interrelationships. In these studies experimental enclosures and check enclosures have been set up for ground squirrels, pocket gophers, and kangaroo rats, and the former stocked to determine the quantity and kinds of forage consumed by each rodent. The biologist at this station is also cooperating with the Forest Service in studies of quail management and coyote-deer relationships.

The research suspended for nearly a year on the Pillsbury State Forest, in New Hampshire, was resumed in April, with special emphasis, as formerly, on the ruffed grouse. Wildlife-management studies included observations on response to cover manipulation, on the movements and seasonal requirements of game, and on cultural methods for use in cover management. Practical measures employed included the encouragement or planting of satisfactory food plants after experimental work to determine the requirements of the plants and of the wildlife species for which intended.

In an investigation of transplanted beavers, conducted in Oregon in cooperation with the Forest Service, special attention was paid to the food requirements of these animals and to the suitability of the colonization sites.

Under a cooperative agreement with the Forest Service, evaluations of national forests as wildlife areas have been made in Minnesota, Wisconsin, Michigan, New Hampshire, Vermont, Virginia, West Virginia, Kentucky, North Carolina, Tennessee, Georgia, Florida, Mississippi, Louisiana, Arkansas, Missouri, and Oklahoma. Among recommendations made were the following: That before roads or trails are built, or recreational areas established, the regional and forest wildlife technicians be consulted; that forest-road develop-

ment be analyzed and that where it is determined that roads are largely for administrative use they be closed to the public; that general stream surveys be made with the idea of selecting beaver-planting sites; that special attention be given to the livestock-grazing problem, to determine forest areas where recreational and wildlife uses might be of greater value than grazing, and that where the two are in conflict, control should be by regulation and strict patrol; that wildlife data be assembled and laid before the State game departments, and a mutual plan of action be agreed upon; that parts of forest nurseries be devoted to raising seedlings of wildlife food plants; that technicians be consulted and careful consideration and study be made, and an agreement reached, as to areas that should be reserved for game; that all forest uses be correlated closely with fish and game uses; and, that insect and rodent control be undertaken only where technical supervision can be furnished from the Bureau of Entomology and Plant Quarantine and the Bureau of Biological Survey, respectively.

#### BIOLOGICAL RESEARCH ON REFUGE AREAS

##### WICHITA MOUNTAINS WILDLIFE REFUGE

Work has been continued on an extensive research program for the Wichita Mountains Wildlife Refuge, in Oklahoma, and, although the laboratory building has not yet been completed, a biologist stationed there began work on January 1 on several problems. Plants have been collected for identification as a basis for cover-type studies, a cover-type map made of a 75-acre enclosure in the northwest corner of the refuge, and a cover-type study of Winter Valley pasture completed, the area mapped, and a survey made for fencing three experimental pastures.

##### PATUXENT RESEARCH REFUGE

The Patuxent Research Refuge area in Maryland was first occupied by the Bureau on May 15, 1936, by permission of the Resettlement Administration, 7 months before the refuge was established by Executive order, December 16, 1936. Its development has proceeded as expeditiously as possible with a small personnel, and preliminary surveys have been made of the existing plant and animal life. Thirteen miles of 9-foot nonclimbable fence have been erected in a boundary strip cleared 20 feet wide to facilitate its maintenance; 4 miles of service roads have been graded and graveled and 12 miles of trails cleared for patrol work; and 45 buildings and other structures that constituted a fire hazard have been razed and the usable material salvaged. A 60-acre tract is being cleared for a dam and pond to provide suitable habitat for waterfowl and other forms of aquatic life. A battery of 24 small ponds for experimental waterfowl-food studies is almost completed, and a well has been dug for a water supply. Pens for 32 minks and 24 foxes have been erected, and foxes for experimental work are now maintained on the refuge.

##### BEAR RIVER MIGRATORY BIRD REFUGE

Census methods for migrating, concentrating, and nesting waterfowl have been studied at the Bear River Migratory Bird Refuge, Utah, weekly censuses of the birds taken, concentrations mapped and recorded, and, through cooperation of the War Department, estimates of bird rafts in the Bear River delta made at intervals from airplanes. An investigation of the mammals of the refuge was begun during the year, and studies were made on the sex ratios of ducks and muskrats.

#### WILDLIFE-MANAGEMENT RESEARCH

##### COOPERATIVE RESEARCH UNITS

Nine units organized to undertake research in wildlife management have been established in cooperation with land-grant colleges and State game departments, funds for each of which are provided by the college, the State game department, the Bureau of Biological Survey, and the American Wildlife Institute. Research, education, and demonstration have gone forward, and the friendly cooperation, the attitude of the participants, and general recognition of the importance of the work have been most encouraging. Some of the accomplishments are here outlined, the information in more detail being available in a mimeographed leaflet (BS-87), covering the project from its inception to the end of January 1937.

The major problem handled by cooperators at the Alabama Polytechnic Institute, at Auburn, has been a study of the life history and management of the mourning dove. During the year nesting activities and food habits have received especial attention. Quail habits and management also have been studied, and advance has been made on an ecological study of the white-tailed deer.

In Connecticut a game-management demonstration area of 4,500 acres has been under management by cooperators from the State College at Storrs. An extensive study of the New England cottontail is under way, special attention having been paid to breeding and food habits and to home and seasonal range. Analytical study has developed a standard technique for appraisal of statistics of the game kill and for short-cut methods that will give necessary information for decisions as to hunting regulations 4 months prior to the season.

At the Iowa State College, at Ames, a study of the ecology and management of the blue-winged teal has been completed for publication. Progress has been made on an investigation of Mearns's cottontail rabbit, especially as to food and cover requirements, and on other researches into the life history, ecology, and management of the muskrat and of the American coot.

An investigation of forest-game relations has made progress from headquarters at the University of Maine, at Orono, in determining the effects of logging and pulpwood cutting on the welfare and distribution of game. Field work was begun in July also on a study of certain habits of the woodcock and of management manipulations necessary for its increase, a map showing distribution and relative abundance of the species in Maine was completed, detailed study was made of its "singing grounds" and nesting, and 73 individuals were banded.

A number of wildlife-management demonstration areas of township size have been set up in northwestern Ohio by the cooperative unit at the State University, at Columbus, where the effectiveness of various production and harvest techniques is being tested. Attention is being given also to the adjustment of farmer-sportsman relationships, a subject treated in some detail in a mimeographed leaflet (BS-93) issued by the Survey in April. Effort is being made to develop a waterfowl-management program for Pymatuning Lake on the Ohio-Pennsylvania boundary. A wildlife, recreational, and land-use study of 52,000 acres of State-owned forest lands in the unglaciated hills of southern Ohio includes the establishment of demonstration areas for controlled hunting, forest plots managed for forest wildlife, 12 special managed refuges and sanctuaries, a nursery, and extensive wildlife plantings. Life-history and management studies have been initiated on the gray squirrel, fox squirrel, white-tailed deer, and ruffed grouse.

Year-round investigations of small game in Willamette Valley, Oreg., were conducted by the unit at the State College, at Corvallis, in which it was learned that food, cover, and range were ample, but that there was a high mortality of immature birds because of unfavorable climatic conditions. A study of sex and fawn ratios of deer was conducted, and considerable progress made in research on the life history and management of the antelope. A 3,000-acre tract comprising several farms in the Willamette Valley was utilized as a game-management demonstration area.

A survey of the wildlife resources of Walker County, Tex., undertaken by the unit at the Texas Agricultural and Mechanical College, at College Station, has included an extensive quail census, a collection of birds, mammals, reptiles, and amphibians, and a study of their habits and of the wildlife utility of the principal vegetative types. Quail in Walker County were estimated at 40,255, and the average covey size on December 1, on grazed and hunted areas, was 11.25 birds, and on ungrazed areas protected from hunting, 16.8 birds. Findings indicate the possibility of more than doubling the quail population of the county through improvement of the habitat (particularly by control of grazing) and better regulation of hunting. A study of the gray squirrels and fox squirrels of eastern Texas has made headway.

The Texas unit has been active, through research, education, and extension, in efforts to conserve Attwater's prairie chicken, a subspecies now limited to a comparatively small area on the coastal prairie of the State. An estimate of its population last fall on 100,000 acres of 3 of the best counties gave 380 birds, or 1 to 263 acres. During the legal hunting season of 4 days, 45 of these (12 percent of the total population) were taken. Latest counts indicate a total of 625 of these prairie chickens in Colorado, Austin, and Wharton Counties. Through shortage of cover as a result of overgrazing or burning, the prairie chickens tend to nest in damp depressions bordering ponds, where they can find

concealing vegetation, but this exposes them to abnormally heavy losses from floods. Ninety percent of the young birds are estimated to have been lost during the 2 years 1935 and 1936. Fortunately a 5-year closed season was placed on this bird at this year's session of the Texas Legislature. The lesser prairie chicken of the Texas Panhandle is also in danger of extinction.

Through questionnaires, interviews, and field observations, a beginning has been made on an inventory of vanishing wildlife in Texas. Principally involved are certain species of big game and other large mammals, fur animals, hawks, and game birds. Some of these are reduced almost to the verge of extinction, and with few exceptions the trend for nearly all species, particularly game, is downward. Outstanding exceptions are the white-tailed deer and the wild turkey of the Edwards Plateau and southern Texas.

Investigation of the Rocky Mountain mule deer, the primary study of the unit at the Utah State Agricultural College, at Logan, has involved a wide variety of life-history features, distributional and forage requirements, and management problems. Particular attention has been given to sex ratios, winter losses, forage requirements, and migrations, and to the yield of deer on a given area and the various factors that enter into harvesting the crop.

A life-history and management study of the sage grouse, largest of native American grouse, was continued in Utah, with year-long observations on activities, migration, breeding, and feeding habits, and conditions affecting abundance. A series of 63 nests was studied through the incubation and hatching periods in an investigation of factors influencing hatching and the rearing of young. A definite correlation was found between type of cover and success of nesting. Sixty-five stomachs were collected for food analysis, mostly from birds struck by traffic on a highway.

The Utah Fish and Game Department cooperated in a State-wide beaver survey and in an intensive study of an 8-mile section of the Strawberry River, which contained 102 beaver dams and 991 acres of willows for forage. During October and November the pelts of 108 beavers, believed to be about half of the population of this area, yielded \$1,022, or about \$1.03 an acre.

The major research effort of the unit at the Virginia Polytechnic Institute, at Blacksburg, was the investigation of the life history, conservation, and management of the wild turkey. A method of producing the birds for restocking purposes was developed. Poults reared in a modified type of the Coleman movable quail pen were found to be wild to a remarkable degree when released, and later were not unduly decimated by shooting. Both deer- and grouse-management studies have been undertaken, and progress has been made in research on the food habits of foxes. Some 2,000 plant specimens have been collected for beginning a study of the distribution and ecology of native plants of the State that are utilized by wildlife. A check list of the birds of Virginia has been compiled, and good progress made on a study of the mammals.

#### WILDLIFE MANAGEMENT A SUPPLEMENTARY FARM ENTERPRISE

An investigation in cooperation with the Bureau of Agricultural Economics, begun in May 1936, of wildlife management as a supplementary occupation on farms, was continued throughout the year 1937. In a reconnaissance survey conferences were held in each State with the agricultural experiment station directors, their staffs, Federal and State land-use specialists, foresters, and others invited by the director to be present, and also wherever possible with members of the conservation departments and of State planning boards.

The outstanding results have been the stimulating of attention and interest and the bringing together of individuals and organizations that have some interest in the production, administration, and utilization of wildlife, particularly as related to agriculture and land use. The study thus far indicates that wildlife, to be perpetuated, must be produced by natural reproduction on farm lands as well as on lands publicly owned. State or Federal lands alone cannot supply sufficient wildlife or adequate facilities for its use and enjoyment by the public. Artificial propagation and restocking have proved to be unduly expensive as a direct means of providing hunting; and uncontrolled public shooting, especially on private farm land, has proved destructive both to wildlife and to farm property. Due respect for property rights is fundamental to success in encouraging private landowners to produce wildlife. The monetary consideration, particularly on lands of high value that are intensively used for agriculture, is of minor importance and under present conditions is not offering an adequate incentive for wildlife production on farms.

Inspection of wildlife-management work on Resettlement Administration projects in Maine, Maryland, and Rhode Island and reports and recommendations on management measures were made at the request of Resettlement regional directors. To summarize briefly the technology of wildlife management the Survey issued a leaflet (BS-67) on the subject in October, and later it was included in essence in a report of the National Resources Committee (pp. 135-136), on Technological Trends and National Policy.

### BIOLOGICAL INVESTIGATIONS IN ALASKA

#### BUFFALO AND MUSK OX HERDS

Information procured as to the status of the buffalo brought 7 years ago from Montana to a point near McCarty, Alaska, shows a sixfold increase in the herd and the animals in good condition. The musk ox herd introduced into Alaska in 1930 was carefully tended and studied at the Bureau's experiment station at Fairbanks until last July, when the 27 animals remaining were transferred to Nunivak Island to join 4 others similarly transferred in a preliminary experiment in 1935. With care and protection this nucleus should thrive on Nunivak Island, and recent reports indicate that the herd probably will increase sufficiently to provide stock for reestablishing the musk ox as an important member of the mammalian fauna of Alaska.

#### WILDLIFE SURVEYS OF ISLANDS

The biological survey of wildlife conditions on the Aleutian Islands begun last year has been continued to the point where its early completion is foreseen. A field party of three biologists assigned to the work embarked this year from Seattle, on May 4, in the Bureau's patrol boat *Brown Bear*. Exploration began at the westernmost islands and continued eastward toward the mainland. As a result of the survey considerable data have thus far been obtained on the bird life of the Aleutian Islands, several new nesting records have been established, and information has been acquired on the breeding birds, their relative abundance, and the effects upon their numbers of foxes introduced on the islands.

### BANDING GAME AND OTHER BIRDS

#### COOPERATORS

Physical limitations on maintaining the great mass of detailed bird-banding records with a high degree of accuracy dictate adherence to the policy of restricting the number of bird-banding stations. Despite the fact that offers of co-operation have been declined on the average of about 1 a day, there has been a slight increase in the number of banding cooperators, and at the close of the year the names of 2,129 were carried on the rolls. Of these 66 maintain active waterfowl stations, 21 on Federal refuges. Banding work also is becoming increasingly important in the national parks, with 16 active stations, chiefly in Western States.

A review of the activity of individual cooperators discloses that during the year 11 of them banded more than 5,000 birds each. The work of one of these aides set a new record for banding a single species, chimney swifts, his total for the year being 22,135. The operator next in line banded 20,128 birds, largely common terns. The third reported a total of 17,458 birds, chiefly waterfowl, a line of banding work that is especially valuable to the Bureau. Cooperators at 49 other stations reported the banding of more than 1,000 birds each during the year.

#### NEW BIRDS BANDED

The grand total of new bandings reported is for 300,207 birds of 391 species, an increase of more than 25,000 over the number for the previous year, including the following 9 species not heretofore banded: Paroquet auklet, parasitic jaeger, bridled tern, white-bellied booby, great white heron, Hudsonian curlew, Worthen's sparrow, Swainson's warbler, and hermit warbler. The number of bands purchased and issued was 415,000. Birds banded in greatest numbers were the chimney swift (29,112), common tern (25,354), herring gull (16,304), mallard (15,753), white-throated sparrow (15,716), and pintail (11,767). Records of banding by species are made known to cooperators in various issues of Bird Banding Notes (mimeographed).

That the banding of migratory waterfowl continues to receive close attention is shown by data in table 1. With the establishment of stations on national wildlife refuges that have resident managers, this phase of the work can be made more selective, since actual operations will be under immediate supervision. In view of this development, and to simplify administration, few additional waterfowl-banding stations of the volunteer class are being authorized.

TABLE 1.—Waterfowl banded in the fiscal years 1936 and 1937

| Species                     | 1936   | 1937                | Species                  | 1936   | 1937   |
|-----------------------------|--------|---------------------|--------------------------|--------|--------|
| American merganser.....     | 12     | 7                   | Lesser scaup.....        | 906    | 7 969  |
| Red-breasted merganser..... | 2      | 10                  | Ring-necked duck.....    | 1,357  | 951    |
| Hooded merganser.....       | 10     | 7                   | Goldeneye.....           | 2      | 3      |
| Mallard.....                | 14,526 | <sup>1</sup> 15,753 | Bufflehead.....          | 55     | 43     |
| Black duck.....             | 4,283  | <sup>2</sup> 4,892  | Harlequin duck.....      | 6      | —      |
| Florida duck.....           | —      | 44                  | American eider.....      | 1      | —      |
| Gadwall.....                | 173    | 1,238               | Pacific eider.....       | —      | 2      |
| Baldpate.....               | 657    | 1,426               | White-winged scoter..... | 1      | —      |
| Green-winged teal.....      | 2,642  | 4,803               | Ruddy duck.....          | 16     | 36     |
| Blue-winged teal.....       | 2,475  | 4,740               | Snow goose.....          | —      | 9      |
| Cinnamon teal.....          | 215    | 183                 | Blue goose.....          | 68     | 96     |
| Shoveler.....               | 100    | 349                 | White-fronted goose..... | 4      | 1      |
| Pintail.....                | 11,894 | <sup>3</sup> 11,767 | Canada goose.....        | 436    | 386    |
| Wood duck.....              | 597    | <sup>4</sup> 888    | Whistling swan.....      | 3      | —      |
| Redhead.....                | 521    | <sup>5</sup> 927    |                          |        |        |
| Canvasback.....             | 553    | <sup>6</sup> 226    | Total.....               | 41,742 | 49,822 |
| Greater scaup.....          | 227    | 66                  |                          |        |        |

<sup>1</sup> Including 1,434 hand-reared mallards.

<sup>2</sup> Including 1,279 hand-reared black ducks.

<sup>3</sup> Including 519 hand-reared pintails.

<sup>4</sup> Including 430 hand-reared wood ducks.

<sup>5</sup> Including 110 hand-reared redheads.

<sup>6</sup> Including 41 hand-reared canvasbacks.

<sup>7</sup> Including 50 hand-reared lesser scaups.

#### RETURNS AND RECOVERIES

During the year 17,011 records were reported of the recovery of banded birds, either at the station of banding or elsewhere. This is 1,257 less than for the previous year, but may be accounted for by the shorter shooting season of 1936, which materially reduced the waterfowl kill by sportsmen. The cards carrying banding data are punched and automatically distributed in the files, but because of a considerable accumulation, amounting to about 35,000 cards, the Survey was assisted in the tabulating-machine work by the Bureau of Agricultural Economics.

#### RECORDS OF BIRD DISTRIBUTION

Data in the card index of the distribution and migration of birds were increased during the year by 39,000 entries, bringing the total number of cards in this file to well over 2,000,000. Migration observers regularly reporting now total 383. Additions to the list are made only when the prospective cooperator is favorably located and is qualified to contribute worth-while information. Further, now that the files are so large, special care is exercised to see that only usable references from the literature are added.

Work on bird-distribution maps is now well under way, and those for the group of gulls and terns, nearly completed, will be followed as soon as practicable by those for the cuckoos, woodpeckers, goatsuckers, hummingbirds, and swifts. These groups will figure in the next bulletin of the United States National Museum on the life histories of North American birds, for which the parts on distribution and migration will be prepared in the Biological Survey, as for the bulletin issued during the year on the life histories of the birds of prey. A series of maps showing original and present breeding ranges has been completed for certain important migratory and upland game birds, as well as for the larger game and fur mammals. When complete it should provide significant information for the use of legislative committees and for conservationists and other students of wildlife conditions.

Circular No. 428 of the Department, issued in May, entitled "Flight Speed of Birds", summarizes and tabulates information not only for game birds but for many other species also and presents an extensive bibliography on the subject.

## STATE SURVEYS AND REPORTS

Studies of the mammals of Florida, which have been carried on intermittently since 1918, were considerably advanced as a result of 2 months' field work in the peninsula. Investigations have been continued also on the life zones and mammals of Arizona, where several man-months have been spent in intensive field study. An extensive monograph describing the life zones of Oregon and the relationships, habits, and distribution of the mammals of the State was published in August as North American Fauna No. 55.

Substantial progress was made on a revision of the manuscript on the bird life of Texas, in connection with which a taxonomic revision of the western screech owls was necessary, and resulted in the preparation for publication of descriptions of three new subspecies; similar byproducts of the Texas work were descriptions of a new jay and a new towhee, and further revisions, wholly or partly completed, of the long-billed marsh wrens, song sparrows, Maryland yellowthroats, hermit thrushes, and cowbirds.

A leaflet (BS-76) entitled "Some Suggestions for Bird Field Study" was issued in December to aid individuals and bird-study clubs in deriving permanent benefits from what to some has been merely a passing hobby.

## REFERENCE COLLECTIONS AND RECORDS

The research collections and records of mammals, birds, and other vertebrates continue to be a necessary foundation for the work of the Bureau. Consistent advance has been made in assembling and recording information based on the collections and on reports regarding the habits, life histories, relationships, and distribution of species. During the year 855 mammal specimens were added to the Biological Survey collection at the United States National Museum, and 712 were identified for 38 institutions and individuals in 22 States and 2 foreign countries. Specimens to the number of 557 were borrowed for study from 11 institutions in 7 States, and 581 were lent to 18 institutions in 7 States and 2 foreign countries.

The facilities of the mammal laboratories were used by 33 research workers from 12 States and 2 foreign countries. Biologists of the Bureau also have used the collection in describing 16 new mammals of the genera *Canis*, *Felis*, *Peromyscus*, *Dipodomys*, *Tamiasciurus*, *Glaucornys*, *Antrozous*, and *Ovis*, and a biologist from the University of California described a new *Mustela* in the collection. Mammal type specimens in the Biological Survey collection now number 949, and a catalog of them for publication in the North American Fauna series is nearing completion.

Bird specimens added to the Biological Survey collection during the year numbered 1,540, and 908 birds were identified for collections of 63 institutions and individuals in 32 States. Loans from the Survey's collection to 15 institutions and individuals in 8 States aggregated 472 specimens. Biologists of the Bureau using the collection described six new birds of the genera *Otus*, *Strix*, *Glaucidium*, and *Rallus*. A taxonomic revision of the clapper rails (*R. longirostris*) was in press at the close of the year.

As part of a general revision of all squirrels, a taxonomic revision of the red squirrels (*Tamiasciurus*) has continued and is now about half completed. Progress has also been made on a revision of the American wolves (*Canis*), and further study made on the taxonomic relations and distribution of the pumas (*Felis*).

## ECONOMIC STUDIES OF WILDLIFE

## WATERFOWL FOOD INVESTIGATIONS

## IMPROVED CONDITION OF EELGRASS

Improvement in the status of the sea brant, a species dependent to a large extent on eelgrass (*Zostera marina*), may be recorded as a result of the definite gain the eelgrass has made in the past year, following diminution in the wasting disease prevalent along the Atlantic coast. Inspections of eelgrass beds, made during the fall and winter throughout the range of the plant from North Carolina to Maine, have demonstrated healthy new growth from Long Island northward, though these beds have not attained sufficient magnitude to deflect sea brant in any numbers from a direct flight to their most important winter-

ing grounds in New Jersey. In limited areas of reduced salinity, as in the Chesapeake Bay, the new stands have been encouraging. A report (Leaflet BS-94) entitled "Status of Eelgrass on the North Atlantic Coast, January 1937," presents detailed information on the observations and experimental plantings conducted during the year and on the present relative abundance of the plant.

Along the whole of the former eelgrass range in the eastern United States, the continued increase and spread of wigeongrass (*Ruppia maritima*), a submerged aquatic of recognized value as a waterfowl food, is an interesting corollary of the diminution of the eelgrass. Having a high tolerance for salt, wigeongrass can thrive in waters varying from fresh to strongly saline and is serving as an excellent substitute for the eelgrass.

#### TRANSPLANTING WATERFOWL FOOD PLANTS

Repeated efforts to transplant seemingly healthy Atlantic-coast eelgrass have met with failure. The plantings that were reported last year of the Pacific-coast form have all disappeared except one lot in Plymouth Harbor, Mass., which has a chance of survival since three of the plants have flowered. Because several of the transplantings thrived at first, more were brought from the Pacific coast and set out during February and April in 23 suitable localities from Maine to North Carolina. Some of these have disappeared though others have survived.

Of the various waterfowl foods experimentally propagated in the State of Washington, wildeelery (*Vallisneria spiralis*) alone has proved susceptible of widespread cultivation. Though delta duckpotato (*Sagittaria platyphylla*) and wilddrice (*Zizania aquatica*) were successfully grown under controlled conditions, no success attended efforts to grow banana waterlily (*Castalia flava*) in that State. Experimental plantings of both eelgrass and wildeelery made during the spring on the Bear River Migratory Bird Refuge, Utah, have been unsuccessful.

#### PROPAGATION OF DUCK FOOD PLANTS

The various marsh and aquatic plants have so long been of economic value to man—either directly, as food for himself and his domestic animals, and as materials for building, caning, and basketry, or indirectly, as food for game species—that there has arisen a great variety of local names for them. There has also been much confusion in their scientific names. With the initiation of a program of experimental propagation and transplantation of waterfowl foods and control of their competitors, the need has been recognized for a clear concept of what species is meant by the terminology employed. A Check-list of Marsh and Aquatic Plants of the United States (Leaflet BS-72), issued by the Bureau in December to meet this need, records the scientific and vernacular names of 948 species of 75 families that enter into consideration in the improvement of waterfowl habitats. In addition, much bibliographical work was completed on the growth and reproduction of marsh and aquatic plants under both natural and artificial conditions.

Transplanting the vegetative growth of aquatics promises the quickest and surest method of waterfowl-food propagation under similar local conditions, but as this method is not always practicable other means must often be used. Spring planting of seeds offers intensive possibilities, but the seeds of marsh and aquatic plants are not so readily held over in viable condition as are those of land plants. To obtain a better basis for propagating waterfowl food plants from seeds, investigations of means of harvesting, storing, and germination were carried on during the year. In the fall seeds of 40 of the more desirable species, including 8 pondweeds (*Potamogeton* spp.), 8 bulrushes (*Scirpus* spp.), and 7 smartweeds (*Polygonum* spp.), were collected on various waterfowl refuges throughout the country. To permit the after-ripening that is essential to germination, each of these kinds of seeds was subjected to the following three methods of storage for periods varying from 4 to 6 months: (1) Immersion in water at approximately 36° F.; (2) keeping dry but in damp air at approximately 36°; (3) keeping dry at room temperature. In addition the seeds of a few species were stratified in wet excelsior, and some of these germinated when others, treated according to the first three methods, failed to do so. Simultaneously tests were conducted on the storage requirements of tubers, rootstocks, and vegetative reproductive parts of common marsh and aquatic plants.

## WATERFOWL FOODS FOR UNUSUAL SITUATIONS

Though the plant has long been familiar to botanists, the value of the dwarf spikerush (*Eleocharis parvula*) as a waterfowl food has only recently become apparent. Because of its growth habits and small size it is most satisfactory as a food for shoal-water ducks. Though occurring commonly in brackish mud flats and shallow waters, it is widely distributed, hardy, and surprisingly adaptable and will grow in fresh-water marshes. Other duck foods observed to be valuable for unusual situations include tidemarch acrida (*Lenida canabina*), waterhyssop (*Bacopa* spp.), and rice cutgrass (*Leersia oryzoides*).

## FOOD RESOURCES OF REFUGE AREAS

Areas proposed for acquisition as refuges for migratory waterfowl were surveyed as to food resources in the New England States, New York, Georgia, Missouri, Kansas, Montana, Idaho, Wyoming, Arizona, Nevada, Washington, and California, and planting programs were outlined for several. Federal refuges in Georgia, Oklahoma, Oregon, and California were inspected, and experimental plantings were suggested for improving them both for waterfowl and for upland game. Inspections of refuge and sanctuary areas, each involving the preparation of a planting program, were made in Maine, Vermont, Connecticut, New York, Pennsylvania, and Wyoming, in cooperation with the Resettlement Administration, the Forest Service, and the Fort Benning (Ga.) Military Reservation, and for various private interests.

## ECOLOGICAL OF WATERFOWL FOOD PLANTS

The measuring of chemical and physical changes in the famous coastal ducking waters of the South is continuing. The demand for navigation channels and inland waterways, and their increasing use, involve continuous dredging operations, and the resultant joining of formerly unconnected bodies of water by canals causes a progressive alteration of the physicochemical balance in the feeding areas upon which ducks and geese depend. When turbidity or pollution so alters ecological conditions as to menace aquatic food plants of waterfowl this Bureau undertakes to ascertain whether lock construction or other remedial measures are practicable.

That the maintenance of an aquatic flora requires relatively stable environmental conditions was again demonstrated in Currituck Sound, N. C., and Back Bay, Va. Following a hurricane in September 1936 the locks at Great Bridge, Va., were opened, and within a short time increased salinity and pollution were evidenced in the plasmolysis and death of sago pondweed, redhead grass, wigeongrass, and other submerged aquatics. When the locks were again closed the conditions in the sound improved.

Experimental work on the Louisiana coast on the physicochemical optima for aquatic plants was initiated at the Delta Migratory Waterfowl Refuge. The rate of diffusion of chlorides from subsoils through topsoils into impounded waters in areas well supplied with natural salts has been studied in the Bear River Marshes, Utah, to ascertain any possible deleterious effects on the valuable pondweeds.

## SUPPRESSING COMPETING PEST PLANTS

Encouraging results have followed the spraying of several sample plots of marsh weeds in 1935 to test the effectiveness and permanency of various chemicals in controlling or eradicating competing and objectionable marsh plants. The work has not yet progressed sufficiently far, however, to permit recommendations regarding spray formulas. Further tests will be made during the coming year.

The introduced alligatorweed (*Alternanthera philoxeroides*), once viewed as a possible waterfowl food, is proving to be a serious pest in fresh and brackish coastal waters from North Carolina to Louisiana. Its relationship to the marsh flora and fauna is now being studied in the Delta Migratory Waterfowl Refuge, La. Though alligatorweed appears to harbor a good animal population, there is little doubt that it is an adventive plant that should be held in check when it tends to choke up water areas and smother valuable food species; it reproduces vegetatively with great ease and matures practically no seed. Since a

piece of broken stem comprising a single node, internode, and leaf axil is capable of producing an entire plant, the practice of mowing or pulling up the plant and throwing it on the shore, or on other masses of vegetation, fosters its chance of survival and spread, instead of destroying it. The only control methods that have thus far proved effective involve the drying out of an area or the rooting out and maceration of the entire plant, since chemical treatments that would destroy the pest would render the area unsuitable for more desirable growths.

#### MOSQUITO CONTROL IN WILDLIFE HABITAT

Areas in Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, South Carolina, Alabama, Tennessee, Kentucky, Illinois, Missouri, Louisiana, and California were surveyed to determine the effect of mosquito-control ditching operations on wildlife and its habitat and food resources, in order to permit the recommendation of control measures less injurious to marsh-inhabiting species. The control of mosquitoes is necessary to the health and comfort of the population of cities and towns, but in places remote from human habitation it is quite a different matter to drain marshlands, swamps, and ponds and thus lower water tables, develop worthless thickets, and eliminate useful aquatic plants and animals upon which the ecologic balance and the wildlife values of land and adjacent waters depend. Much of the drainage for mosquito control has been undertaken without the guidance and advice of entomologists and biologists and thus has been unnecessarily destructive to game and fur mammals and birds. Under competent supervision, the results have been far less detrimental to wildlife.

The destructive effects of mosquito-control operations on wildlife habitat have been caused chiefly by altering natural water levels beyond the limits that most of the desirable plant and animal forms can tolerate and by lowering the levels of ponds, thus destroying valuable submerged plants by subjecting them to injurious exposure or desiccation. In many instances the lowering or excessive fluctuation of water levels as a result of ditching has led to the elimination of indigenous plant and animal forms and to invasions of undesirable plants that rapidly displace species useful to waterfowl and other valuable wildlife.

Other interested Federal and State agencies have cooperated with the Bureau in experiments concerned with studies of mosquito breeding in different types of ponds and marshes and of control measures not seriously injurious to the valuable flora and fauna. Recommendations have been made that where possible water levels be adequately controlled through the use of sluices, tide gates, and other means, and that mosquito breeding be checked by the use of killifishes, top minnows, and other predatory enemies of mosquito larvae.

In several instances cooperative efforts have resulted in the preservation or partial restoration of marshlands valuable to wildlife. Evidence has been obtained that permanent ponds on salt marshes rarely provide suitable breeding environment for mosquitoes and as a rule need not be eliminated in mosquito-control work. This has resulted in the saving to wildlife of many marsh ponds along the North Atlantic coast and in the restoration of others through the installation of dams in the ditches that formerly drained them.

Biological, chemical, and engineering devices are all being investigated in an effort to solve the wildlife aspects of the mosquito-control problem. In some localities the impoundment of waters on the marsh has been successful. Larvicides, such as pyrethrum, have been found as effective in mosquito control as fuel oil and far less destructive to wildlife. Worth-while progress is being made in this work, but the results have not been unqualifiedly accepted by all mosquito-control workers as alternatives to drainage.

With the cooperation of the W. P. A. many project applications for mosquito control and other drainage operations have been reviewed by the Survey, with the result that some applications have been canceled or the proposed methods of work modified. In many cases, to the satisfaction of all concerned, such modification has resulted in the construction of ponds and other artificial habitat to compensate for the natural wildlife environment unavoidably destroyed by drainage.

Several water impoundments made by the Tennessee Valley Authority, particularly the Wheeler and Wilson Lakes, were inspected during the year preliminary to recommendations for improving food conditions for upland game and waterfowl and to determine what effect mosquito-control operations were having on the wildlife resources of the Tennessee Valley. Effort was made to

assist the Authority in more closely correlating necessary mosquito control with wildlife interests. It was found that much of Wheeler Lake has excellent possibilities for wildlife development, providing compatible methods of mosquito control can be employed. It was recommended that stress be laid upon biological methods of control rather than on the use of oils or other destructive larvicides.

#### LABORATORY RESEARCH IN FOOD HABITS

Reduced field work and increased laboratory investigations were reflected in a greater total number of wildlife-food analyses made this year. Stomachs were examined of 2,482 birds of 78 species, of 586 mammals of 32 species, and of 282 reptiles of 17 species, in addition to 377 pellets of 8 species of birds and 345 droppings from birds of 1 species and mammals of 4. Interesting additions to the list of species of which food has been analyzed were the trumpeter swan (two stomachs) and the pink-footed goose and large-billed puffin (one each).

#### REPTILE COLLECTIONS EXAMINED

Stomachs of 510 snakes were collected in 1936 and 1937 on the George Washington National Forest, Va., through the cooperation of the Forest Service, the largest single reptile collection the Bureau has ever received for food analysis. Of these, 258 of 15 species, collected in 1936, have been examined.

Special effort was made to obtain material in spring and early summer, particularly May and June, in order to cover the nesting period of ruffed grouse, as collections during that time are needed to clarify the relationship between snakes and game birds. It is known that black snakes eat the eggs of game birds, but little is known of the effect of this habit on the increase of the species preyed upon. Little authentic information is as yet available on the food habits of rattlesnakes, copperheads, and other snakes, or on the effect these reptiles have on the abundance of game and other wildlife.

Large numbers of snakes are killed on roads and highways each year, and many of the specimens in the present series were salvaged from such casualties. Among other reptile studies initiated, the investigation of the food habits and economic relationships of the cottonmouth moccasin on the Delta Migratory Waterfowl Refuge, La., is of special importance because that species may be an inhibiting factor in the production of waterfowl and muskrats. For use in answering routine correspondence, revisions of two leaflets on reptiles were issued during the year: *Poisonous Snakes of the United States* (BS-70); and *The American Chameleon and Its Care* (BS-92).

#### MAMMAL STOMACHS ANALYZED

Based on the examination of 14,829 stomachs collected in every month of the year in 17 States, a manuscript was completed for publication on the food habits of the coyote. This has been the major work of the Food Habits Laboratory at Denver since its establishment in 1931 and should aid materially in the consideration of any needed modification of policies as to control of this predator.

Examinations of fecal material collected in 1936 on the Biological Survey expedition to the Aleutian Islands made possible the preparation of a report on the food of the comparatively rare sea otter. This animal is a prized fur species and if its numbers can be increased has great economic possibilities. On the same expedition special efforts were made to obtain information on the food and feeding habits of blue foxes, with particular reference to their effect on the abundance of nesting birds. The data thus obtained will influence management policies for the Aleutian Islands Bird Refuge.

#### FOOD OF BIRDS

To check the dependability of stomach analysis as a method of obtaining evidence of the egg-eating propensities of crows, study of the effect of crow digestion on the shell of hens' eggs was made. Eggshell was force-fed to crows, and autopsies were performed at the expiration of set periods up to 5 hours after feeding. Examinations of alimentary tracts showed that so long as some shell is ingested with the egg, evidence of an egg-eating habit will be present in the stomach and intestine until normally eliminated.

That the barn owl may be a better collector than man has been confirmed by the discovery of remains of the meadow mouse in pellets collected in 1936 on the Cape Romain Migratory Bird Refuge, S. C. Barn-owl pellets collected in South Carolina in 1934 also contained the remains of meadow mice, the first record of the occurrence of the species in the State, despite the fact that interested scientists, after persistent trapping, had failed to reveal the presence there of this small rodent, so common farther south.

Examinations of all the available stomachs of the American coot—totaling 735—have been completed, the information has been tabulated, and a report on the findings is being prepared. The crops and stomach contents of 57 band-tailed pigeons were examined and the data tabulated for use in study and management of this species in California. Much other laboratory work on the food of birds was cooperative in nature and is discussed under the next heading.

A new number in the Survey's leaflet series (BS-84), issued during the year, was devoted to a report on the food habits of the scaled quail. Another Bureau leaflet (BS-19) entitled "Groups of Plants Valuable for Wildlife Utilization and Erosion Control," was revised and published as Circular No. 412 of the Department. Revised lists of dealers in cage birds and cage-bird supplies (Bi-631), dealers in devices for attracting birds (Bi-160), and dealers in peafowl (Bi-1189) were prepared to meet the needs of correspondents.

### COOPERATIVE FOOD-HABITS RESEARCH

#### WILDLIFE ON GEORGE WASHINGTON NATIONAL FOREST

A cooperative food-habits project initiated during the year involved a survey of the available food supplies and a study of the food habits of the game and fur-bearing animals of the George Washington National Forest, Va. Examination of the crops and gizzards of more than 200 ruffed grouse, 5 bobwhite quail, and 72 wild turkeys and of the stomachs of 5 opossums, 22 foxes, and 13 brown bears have been completed. These investigations were made possible through allocation by the Forest Service of Emergency Conservation Work funds for employing three temporary workers for a 3-month period to assist in separating and identifying stomach material. The study will be continued to cover all seasons of the year, especially to ascertain seasonal variations in the food preferences and requirements of game animals. It will be followed by the preparation of illustrated reports on the important foods of each of the major species of game and fur-bearing animals of the forest. The reports will be available to forest rangers and game technicians and will serve as a guide to the management of the resident forest game populations.

#### WILD TURKEY MANAGEMENT

To encourage and increase valuable wildlife on vast forest holdings the Forest Service has entered into a cooperative agreement whereby this Bureau will study the problem of management of wild turkeys in the Missouri Ozarks, where there are eight national-forest units, comprising 3,500,000 acres. A survey of the results of a 10-year restocking program conducted by the State and a study of the present occurrence and response of the wild turkey to management practices formed the basis for a report on The Wild Turkey on the Missouri Ozark Range (Leaflet BS-77).

Special efforts are now being directed toward establishing a native wild turkey management demonstration in the 14,000-acre wilderness refuge and research area on the Clark National Forest. Part of the tract will be fenced, so that grazing animals can be excluded, and it will provide favorable conditions for a study of the effect of grazing on bird populations. Preliminary findings indicate that grazing and illegal hunting are the prime factors in keeping the wild turkey population at a low level despite its high reproductive rate. In addition to the work in field management, 18 crops and stomachs of turkeys and 6 lots of droppings collected in the Ozark section have been examined.

#### MISCELLANEOUS STUDIES

Stomachs of 30 opossums, 2 raccoons, 13 weasels, 3 minks, 97 skunks, and 18 feral house cats were examined for a predator study being conducted at the Kellogg Bird Sanctuary, Mich. A series of 24 otter feces and 14 stomachs of the American merganser were examined for the Michigan Department of

Conservation. A total of 153 ruffed grouse crops and stomachs and 125 fox droppings were examined on a cooperative basis for the New York State Conservation Department. In continuation of the cooperative study with the Pennsylvania Board of Game Commissioners on the food of birds killed for bounty, the stomachs of 54 goshawks, 2 red-tailed hawks, and 4 marsh hawks were examined.

A report on the stomach contents of 98 birds of 24 species and of 8 mammals of 6 species collected in Newfoundland, Labrador, and Greenland, during the 1936 Bartlett Expedition, prepared in collaboration with the collector, will be published by the Field Museum of Natural History.

Stomachs of 89 white-tailed deer, collected in several States, were examined for the Forest Service, and those of predators and a number of small birds were examined for the Soil Conservation Service. Other examinations included 56 stomachs of Texas gray squirrels and 33 pellets of 7 species of Iowa owls for institutions or individuals and long series of material for university cooperators and for those in charge of the management of the Bureau's game preserves and migratory waterfowl refuges. In addition, plants were identified to aid in the Bureau's program of migratory waterfowl restoration; seed material was determined for university cooperators in Texas, for the Cooperative Quail Study Association in Georgia, for the Resettlement Administration, and for numerous other organizations and individuals; and assistance was given in identifying several hundred fossil seeds for the University of Iowa.

### FIELD INVESTIGATIONS OF INJURIOUS SPECIES

#### CROW-WATERFOWL RELATIONSHIPS ON BREEDING GROUNDS

Crow-waterfowl investigations, made during the breeding seasons of 1934 and 1935, on three waterfowl nesting grounds in Canada, clarified a number of points with respect to crow depredations on the eggs and young of waterfowl. The results of these studies were published in June in Circular No. 433, of the Department, entitled "Crow-Waterfowl Relationships: Based on Preliminary Studies on Canadian Breeding Grounds." During the last 2 years the studies were extended to the Lower Souris Migratory Waterfowl Refuge, N. Dak. In contrast with the results obtained in 1934-35 in Canada, where the crow was responsible for the destruction of 31 percent of the duck nests under observation, only 1.7 percent of the nest destruction at the Lower Souris Refuge in 1936 was attributable to crows, while 30.6 percent was caused by skunks forced into the lowland nesting areas by drought conditions. In 1937 the situation altered again, and foxes were found to be exacting a considerable toll in restricted parts of the refuge. These studies made evident the danger of sweeping generalizations to justify control operations for the betterment of game. They also indicate that treatment of the control problem may have to be varied not only in different areas but even in the same areas in successive years, depending on the numerical fluctuation and drift of the animal populations.

#### EUROPEAN STARLINGS

In a leaflet entitled "Suggestions for Combating Starling Roosts" (BS-81) the Bureau recapitulates most of the practical experimental work on starling control thus far undertaken. Some attention was given during the year to perfecting a method of starling control suitable for use in metropolitan areas, where the roosting birds continue to be a troublesome pest. Efforts also are being made to perfect traps suitable for taking starlings. A noticeable reduction in the number of starlings wintering in Washington, D. C., last year, may indicate a tendency of these introduced birds to follow the course of the English sparrow toward a lower level of abundance.

#### ARMADILLOS IN TEXAS

Field work carried on in Texas at intervals during 4 years on the relation of the armadillo to the nesting of the bobwhite quail has been completed. Tests of armadillo reaction to dummy and genuine quail nests were practically negative, and the indications are that under normal conditions the quail, unless they are present in excessive numbers, are relatively safe from armadillos. An interesting contribution to the biology of the armadillo was the discovery that these animals inflate the intestine with air to enable them to float.

## ORIOLES IN NEW YORK

In 1935 reports were received of injury to grapes by Baltimore orioles in New York, and a recurrence of their depredations in 1936 precipitated an investigation. This revealed that the rather extensive damage was due to the flocking of young birds in trees adjoining arbors and orchards, from which they emerged to sample sour cherries, grapes, and apples, until a fruit sufficiently soft and appetizing for complete consumption was found. Many bird-frightening devices used there have been ineffectual and more aggressive measures of control were necessary.

## BALDPATES IN WASHINGTON

During a 10-week period, commencing in December, large flocks of baldpates, or American wigcons, invaded the Skagit district in Washington State, in which farmers specialize in growing beet, turnip, and cabbage seeds—crops requiring 2 years to mature. During the exceptionally severe winter the natural feeding areas of these shoal-water ducks were frozen over, thus forcing the birds to search for food elsewhere. At first only the cabbage heads protruded above the snow and these were eagerly seized upon by the ducks, but in feeding they packed the snow down until the turnips, growing between the cabbage rows, also were exposed to their depredations. Through cooperation with State officials, farmers were given aid in protecting their crops under these unusual conditions.

## CROP-DESTROYING BIRDS IN CALIFORNIA

Last year, when horned larks were exceedingly destructive to crops in California, the Bureau issued a leaflet (BS-64) on Protecting Crops from Damage by Horned Larks in California, describing methods that in many instances enabled farmers to cope satisfactorily with the birds. This year, with crows and California jays exceedingly destructive, attention has been devoted to adapting to California conditions methods elsewhere found successful in preventing bird depredations. The second part of a cooperative manual entitled "Procedure and Methods in Controlling Birds Injurious to Crops in California" has been prepared for publication by the State, to serve as a reference and guide to bird-control activities in California. Since knowledge of the individual and flock movements of injurious species is essential to the formulation of control policies and procedure, the banding of birds of offending species, including the western mourning dove, tricolored redwing, and the Gambel's, golden-crowned, and Lincoln's sparrows, all of which occasionally cause damage to agriculture, was continued, and in all, 3,193 birds of 16 species were banded. An order issued by the Secretary of Agriculture empowers State authorities in California to carry on necessary control of species of sparrows and blackbirds protected under the new migratory-bird treaty with Mexico.

## FISH-EATING BIRDS

With a view to reducing the objectionable activities of birds about fishponds and water reservoirs without resorting to measures involving the death of the birds, a Department leaflet (No. 120) was published during the year entitled "Excluding Birds from Reservoirs and Fishponds." A Bureau leaflet (BS-83) also was issued under the title "Birds in Relation to Fishes," as a revision of a mimeographed paper prepared for the use of the Bureau of Fisheries.

## FUR-ANIMAL CONSERVATION AND RESTORATION

## INTEREST IN FUR RESOURCES INTERNATIONAL

The aid of the Bureau is being sought by fur-animal research workers and fur farmers abroad as well as in this country. One delegation from Manchuria visited the Bureau during the year to obtain information on the results of experimental work in fur farming. A member of a firm engaged in international fur trade, with headquarters in Germany, also conferred with Bureau officials, particularly on the development of fur farming in this country, including the breeding of Karakul sheep. A representative of the Bureau addressed fur farmers of Canada at Winnipeg, Manitoba, on the Organization of

the Fur-Animal Research in the United States. At the request of the Treasury Department, arrangements were made to detail a Bureau fur specialist for 3 months to investigate in China certain phases of fur importations.

As a supplement to a similar treatise published last year covering a 5-year period, an analysis of the average prices and percentage distribution according to degree of silver of the silver fox skins marketed in the United States and Great Britain was prepared and made available to the various fur publications.

#### DEMAND FOR INFORMATION INCREASING

To make current information available and to replenish supplies exhausted by an increasing popular demand, a number of mimeographed leaflets pertaining to fur resources and the production of rabbit fur were prepared or revised on such subjects as the following: Raising martens and otters in captivity (BS-63 and BS-75), fur farming in perspective (BS-69), feeding and caring for squirrels (BS-80), sanitation in domestic rabbitries (BS-86), relative weights of young rabbits and does during the suckling period (BS-65), and inheritance of "woolly" in rabbits (BS-73).

The Bureau's contributions to the 1937 Yearbook of Agriculture included an article entitled "The Breeding of Fur Animals," which sets forth accomplishments in the research field, with particular emphasis on the genetics of silver foxes. The need for an extensive program for further research in the reproductive cycles, nutrition, and breeding of various species of fur animals was suggested.

A brief was prepared during the year on the relation of fur farmers to the Social Security Act, and testimony was given by an expert fur witness in litigation involving departmental land-condemnation proceedings in connection with the purchase of certain wildlife refuges.

An encouraging development with reference to conserving fur resources has been an awakened interest on the part of the States and the fur trade. This may be the forerunner of State legislation to require accurate reports by species on the annual catch by trappers. Definite resolutions urging still more effective conservation and restoration of the fur resources were adopted by the fur dealers and conservationists in attendance at the second annual meeting of the North American Wildlife Conference held in St. Louis in March.

#### PROGRESS IN FUR FARMING

Mink raising continues to be the popular phase of fur farming for beginners in the United States. The production of ranch-raised mink pelts is now estimated to reach 100,000 annually in this country, and the average quality is considered superior to those taken in the wild, primarily because breeders can control the stock and make selective matings. Current information was made available by the Survey in a new leaflet, Mink Raising (BS-82).

Fox-farming operations are in a healthy condition, and some expansion has been noted. Bureau records show that approximately 40 percent of all silver fox pelts now produced in the United States are full silvers and that each of the past 6 years has shown an increased percentage of full silvers, primarily because on the average they command prices as much as 45 percent higher than the three-quarter silvers. Breeders are showing increasing interest also in polygamous matings of foxes, a practice studied by the Bureau and reported upon in a leaflet (BS-66).

A study was made of the auction sale price of more than 10,000 silver fox skins produced by one breeder in 1935 under similar feeding and environmental conditions, revealing that pelts from male pups sold for 8 percent more than those from female pups and that in pelts from mature animals the difference in price due to sex was 16 percent in favor of male skins. The primary cause of this price differential is the larger size of the male skin. Pelts from pups in some cases sold higher than those from mature animals.

To offset the increasing prices of raw meat, emphasis is being placed upon economies that will not affect fur quality. The interest that fur farmers are showing in the solution of their problems is reflected in the establishment of fur-animal experiment stations in Colorado by breeders in the Rocky Mountain section, in Oregon by the State Agricultural College, and in Canada, where several Provincial fur-animal stations have recently been organized.

Though most of the fur-farming operations are confined to the fine-furred animals—foxes and minks—interest also is being shown in fishers and other

fur bearers. Either unsatisfactory reproduction in captivity or high rearing costs in relation to pelt prices, or both these factors, have been limiting the extension of fur farming to other species.

Raising domestic rabbits for food and fur has received a stimulus from advancing prices, and raising rabbits for laboratory purposes is still found profitable by many breeders. An unsatisfied demand for domestic rabbits suitable for making pneumonia serum has had an encouraging effect on rabbit raising. The Angora rabbit wool produced in the United States also seems to have found a more extensive and dependable market.

#### RESEARCH IN COOPERATION WITH OTHER AGENCIES

The popularity of Persian lambskins for use in coats and trimming has stimulated activity in Karakul sheep raising in this country in both purebred and grade flocks. Karakul sheep investigations in cooperation with the Bureau of Animal Industry are progressing satisfactorily. Assistance was given by representatives of the Survey in selecting a more complete and comprehensive set of standard sample skins for classifying the experimental Karakul skins as well as live lambs retained for breeding. All skins taken during previous years were reclassified in accordance with the new standards.

Some material for the embryological studies of fur animals in cooperation with the Carnegie Institution of Washington was collected during the year but little was accomplished in studying it, for lack of facilities.

For an investigation of what constitutes a dressed fur skin, undertaken in cooperation with the Bureau of Standards, 72 rabbit skins from the United States Fur Animal Experiment Station were supplied.

A cooperative agreement was drawn up between the Bureau of Chemistry and Soils, which investigates tanning in all phases, and the Bureau of Biological Survey to investigate the influence of breeding, sex, age, season, and environment as factors affecting the quality of raw and tanned furs. Active work will be begun during the coming year.

In cooperation with the Tariff Commission through the Department of State a detailed survey was made of fur resources and fur-manufacturing operations in several foreign countries. The resulting information in the files of the Bureau gives an opportunity of correlating this country's activities with world trends.

An investigation into the relative efficiency of various types of traps was conducted during the year in cooperation with a leading manufacturer. The primary purpose was to obtain information useful in conducting future fur-animal investigations and for control work on refugees and in the field.

The cooperative study with the research department of a large hat corporation on the value of jack rabbit and cottontail fur from various sections of the United States, as a basis for felt-hat making, was completed during the year. Several sample hats were made up entirely of these furs as well as in various blends. The best hat was made from the fur of the Nebraska white-tailed jack rabbit, with blacktails second, and cottontails a poor third. Though a fairly satisfactory hat can be made from these furs exclusively, much superior hats are manufactured from blended furs. Jack rabbit fur has been used for some time in the hat trade, but this study has established the relative value of skins from species from different sections of the country. The findings have been set forth in a manuscript entitled "Utility Value of Jack Rabbit and Cottontail Skins." Similar cooperative research will be extended to other native mammals and to domestic rabbits.

#### FUR ANIMAL EXPERIMENT STATION

To give to the experimental program a permanence that cannot be attained on rented land, Congress appropriated \$21,500 for purchase of the site of the United States Fur Animal Experiment Station, in the Adirondack section, and for construction of needed buildings. The deed was recorded on December 4. Plans and specifications were drawn up by Bureau officials for remodeling the residence and erecting a new office building, a carpenter shop, utility buildings, and a slaughterhouse of uniform design, though the whole program cannot be accomplished with present available funds. The mink shed and furring shed were moved from a site near the highway to make space for the new office building, the construction of which was progressing at the end of June. A commodious and easily accessible parking space was provided for the numerous visitors to the station.

In addition to giving personal information to the increasing number of visitors, the director addressed various other groups and organizations and prepared informational material for the daily press and popular articles on the results of feeding experiments at the station, at the request of publishers of fur-farming journals in the United States and in Canada and other countries.

#### FOXES.

The birth of an abnormally small number of desirable female fox pups last year made it impracticable to cull the breeding stock as closely as desired, but some progress was made, and during the coming year all Alaskan silvers will be eliminated, leaving only the Standard breed in use in experimental work at the station. During the gestation and lactation periods foxes fed rations containing 40 percent of raw meat (on the basis of added water) responded as satisfactorily as those fed rations containing 60 percent. Previous experiments had shown that tankage (4 parts) with liver meal (1 part) was not a satisfactory substitute for the raw-meat portion of the summer and fall ration of adult foxes. This year's experimental work with adults shows that when 10 percent of the ration as fed is composed of raw meat, tankage and liver meal are as satisfactory as beef meal in summer and fall. Weaned pups were fed until pelted time rations in which the raw meat was entirely replaced by an equivalent quantity (on the dry basis) of beef meal (5 parts) and liver meal (1 part). These substitutes were somewhat more economical than the raw meat, but the pups did not make quite as much growth as those fed raw meat. Experts in the fur trade differed as to the effect of these rations on the quality of the pelt—one was of the opinion that pelts from animals fed raw meat showed more sheen and fur growth, while the other could see little difference between the two. Since a cheaper ration may be responsible for a pelt so inferior as to more than offset the saving involved, this point will receive further consideration.

Pieces of block salt were placed in several fox pens for a period of several months, but careful periodic weighings showed that none of it was consumed by the foxes. Either foxes do not require salt or else the rations contained enough to satisfy their requirements. Little progress was made in artificial insemination of foxes.

Toward the close of the year fox-feeding experiments were in progress to determine the results of adding a small quantity of liver meal to the beef meal in the summer and fall feeding of male foxes and of using soybean meal as a partial substitute for dehydrated beef meal for adult vixens. Preliminary tests were made to determine also the desirable proportions of peanut meal and fish meal to replace dehydrated beef meal in the summer feeding of vixens. Information is now being sought on the desirability of using equal parts of dehydrated beef meal and soybean meal as a complete substitute for raw meat in the ration of weaned fox pups when some are to be pelted.

#### MINKS

During the second year of definite feeding experiments on minks, most unsatisfactory results were obtained in substituting frozen codfish for raw meat in the ration of weaned kits during summer and fall. Other kinds of frozen fish have proved satisfactory to commercial ranchers.

Contrary to general expectations, a group of adult female minks that received a ration having 50 percent of raw meat (on the basis of added water) during breeding, gestation, and lactation periods whelped more litters and raised more kits to weaning than did those that received a ration having 65 percent of raw meat, but neither group produced satisfactorily.

#### MARTENS

The most serious problem confronting marten raising is concerned with satisfactory reproduction. Only one litter of two young was obtained from eight adult females, though males were given several mates and females were allowed service by more than one male.

#### RABBIT EXPERIMENT STATION

The widespread interest in the Bureau's research in the rabbit-raising field was shown on two occasions during the year: A field-day meeting for rabbit

breeders, held at the United States Rabbit Experiment Station, Fontana, Calif., in April, was attended by nearly 500 persons, representing 5 counties and 67 cities and towns; another meeting was attended by representatives of 15 milling concerns who wished to obtain the latest information from the feeding experiments conducted at the station. Similar evidence of the public service given by the station is found in the increased correspondence from rabbit raisers.

New and practical equipment developed by the station staff has included a simple and inexpensive screen box for protecting young litters from the time of kindling to the age of 12 to 14 days, thereby eliminating the nest-box heat mortality that has been a disturbing factor in previous experimental work. The nail keg nest box described in Leaflet BS-74 has proved so satisfactory that it has replaced all other types used in the Bureau's experimental work.

#### FEEDING TESTS

The experimental program at the station was materially extended during the year, and on the average about 1,000 animals were employed in various breeding and feeding tests. At the national convention and show of the American Rabbit and Cavy Breeders Association, held at Fort Wayne, Ind., in November, the director of the station presented the results of tests over a 2-year period with a self-feeder designed by the station staff. The facts, together with detailed drawings for accurate construction, were later incorporated in a Bureau leaflet (BS-85), *Self-Feeding System for Market Rabbits*. This almost revolutionary method of feeding domestic rabbits has not only lessened the feed cost per pound of live weight but also has materially increased the rapidity of gain. Numerous commercial rabbit raisers have already installed this system with satisfactory results. Use of the self-feeder also makes it possible for a doe of superior heritage to care for a large litter and increase their weight before they come out of the nest box and begin to eat. The station has consequently been more successful in identifying and segregating those animals having superior germ plasm. Feeding experiments have shown that a plant-protein supplement is essential for rapid and economical gains in rabbits and that milo is a rabbit's first choice of the grain sorghums, though little preference is shown among the other kinds.

Salt-consumption records were obtained over a 1-year period for 10 mature bucks and 43 producing New Zealand does and their litters put on a ration of whole oats, barley, milo, wheat, pelleted plant-protein meal, alfalfa hay, and green feed. During this period the bucks consumed on the average 0.088 pound of salt and the does and their litters 0.195 pound. Based on this test it has been recommended that one-sixth pound of salt be added to each 100 pounds of concentrated feed to supply the rabbit's salt requirements.

#### THE PROBLEM OF FEEDING AND BLOAT

The problem of bloat, or enteritis, in rabbits, is still unsolved despite a careful and extended program of nutritional research during the year. It was found that hybrid vigor incident to crossing the Champagne d'Argent breed with the New Zealand breed is not a factor in preventing mortality from this cause, and a careful and extensive study of the station records establishes the fact that there is no correlation between mortality and inherited susceptibility or resistance. Experiments have shown that there is no merit in frequently changing the ration in controlling mucoid enteritis, and that whole barley as the sole concentrate is not a direct cause of loss. Experiments were initiated during the year for obtaining information as to the effect of various vitamins on this problem. Better control of bloat is essential before the best results from feeding experiments can be obtained.

#### IMPROVING MEAT AND FUR QUALITY

Much information has already been recorded on the feeding requirements of medium-size rabbits, as well as of giant and small breeds, the purpose being to formulate feeding standards for rabbits as definite as are already available for other types of livestock.

Representative pelts of fryer rabbits produced by the self-feeding plan were graded by dealers in raw rabbitskins and by other experts after dressing the natural long hair. The possibilities of increasing the percentage of fryer-

rabbit skins usable in the fur trade is involved and has much practical value because of the higher prices now being paid for skins.

Trial express shipments from California to the east coast of frozen rabbit meat wrapped in paraffined cartons and packed in solid carbon dioxide arrived in excellent condition.

#### BREEDING EXPERIMENTS

An extensive experiment to develop dependable information on the duration of the false pregnancy period of domestic rabbits was practically completed during the year. This required 175 junior New Zealand white does, 4 vasectomized New Zealand red bucks, and 25 New Zealand white bucks. After the doe was served by the vasectomized buck a second mating was permitted by a normal buck to one group after 24 hours had elapsed and to other groups at 24-hour intervals. Definite information on the extent of the false pregnancy period will guide commercial rabbit raisers in their test-mating program in obtaining maximum production.

In October, Department Circular No. 410 was issued under the title "Results From Breeding Rabbits That Are Suckling Young," reporting on experiments conducted at the station over 3 years.

### WILDLIFE DISEASE CONTROL

#### RELATIONSHIP OF DOMESTIC STOCK AND WILDLIFE

Specimens of game and other animals found diseased or dead on various ranges used jointly by domestic stock and wildlife have been studied to ascertain the nature and extent of any possible injurious effects of one type on the other. Grazing animals when present in numbers on a big-game range jeopardize the health of the wild ruminant mammals. Likewise, the maintenance of flocks of domestic poultry on areas frequented by game birds is a potential menace to the wild species. On the other hand, certain parasites have been acquired by domestic stock from association with wildlife. Investigations show, however, that the danger is far greater of passage of disease organisms from domestic herds and flocks to wild species concentrated under management. A paper on this subject was presented by a representative of the Bureau at the second North American Wildlife Conference and is being published in the proceedings for 1937.

In cooperation with the Bureau of Animal Industry, investigations have been made of a situation in Florida, where deer are serving as carriers of tick fever and have been found to be heavily infested with the tropical variety of the fever tick. Research is in progress to ascertain whether parasitized deer are frequent victims of tick fever and also whether they may be affected by or serve as carriers of anaplasma infections, which weaken the hosts by destroying red-blood corpuscles.

Miscellaneous Publication No. 270 entitled "Post-Mortem Examinations of Wild Birds and Mammals," giving directions for use in the study of wildlife diseases, was published during the year.

#### POLLUTION PROBLEMS

Efforts have been increased to gather information on the various phases of water pollution as it affects wildlife, especially waterfowl, and on possibilities for their reduction. Research to solve problems connected with lead-shot deposition in waterfowl areas, which is one of the most serious forms of pollution, has included surveys to ascertain the localities most affected and cooperation with the University of Minnesota in the development of a nontoxic pellet suitable for ammunition purposes. Progress has been made in compounding metallic alloys that would not poison birds that pick them up when feeding in such areas, and if these alloys are found a practical substitute for lead shot, thousands of birds may be saved from death from lead poisoning.

#### DISEASES OF FUR ANIMALS

Disease among fur animals is still a serious obstacle to success in fur farming. While many ranches have fared well others have experienced excessive losses from infectious outbreaks. Among the diseases taking heavy toll among silver foxes is that of canine distemper. This infection, however, as-

sumes distinctly different characteristics in foxes than in dogs, and the method of treatment must be considerably modified. Farmers' Bulletin No. 1777, entitled "Diseases of Fur Animals", in press at the close of the year, deals with this subject at length. Mimeographed leaflets to aid in combating disease outbreaks, where rabbits are raised for food and fur, have been issued as follows: Vent Diseases of Domestic Rabbits (BS-79), Sanitation in Domestic Rabbitries (BS-86), Infectious Myxomatosis of Domestic Rabbits (BS-89), and Hemorrhagic Septicemia of Domestic Rabbits (BS-90).

### ACQUISITION OF LANDS FOR REFUGES

The program of wildlife-refuge land acquisition (table 2) has continued with the funds remaining from the \$6,000,000 appropriation made available for the purpose by act of Congress approved June 15, 1935. On refuges being purchased under emergency funds, 1,050 miles of refuge boundaries, 1,084 miles of necessary auxiliary lines, and 222 miles of level lines were surveyed during the year. Survey descriptions and accurate maps for all completed surveys were prepared concurrently with the completion of the field work.

For real control and conservation, the nature and habits of wildlife make it necessary to have in Federal ownership all lands within the prescribed exterior limits of the refuges established. The requirements of wild birds and mammals and the special nature of the habitats attractive to wildlife limit the opportunities to acquire and restore suitable refuges. A further check on speedy accomplishment of the refuge program within the financial limitation is that title to most of the lands being acquired must be perfected to the satisfaction of the Attorney General by legal action by the vendors or in their behalf or by judicial proceedings in the Federal courts. Numerous proceedings looking to the acquisition of lands by judicial methods were instituted and some of them completed to quiet imperfect titles to lands previously taken under purchase contract and to effect the acquisition of lands on which price agreements could not be reached with the owners.

At a meeting of the Migratory Bird Conservation Commission held on January 12, 1937, lands in 34 units, involving 236 cases and aggregating 134,655 acres, were approved for purchase. The total expenditure involved was \$1,408,737, representing an average cost of \$10.46 per acre. Most of the lands thus approved for purchase fall within units previously in part acquired under the provisions of the Migratory Bird Conservation Act or for migratory waterfowl refuge purposes through the Resettlement Administration. The following deserve special mention:

The Montezuma Migratory Bird Refuge in Seneca County, N. Y., though relatively small, is exceedingly important because of its situation in a highly developed agricultural section in which most of the natural waterfowl habitat has long since been preempted for agriculture.

The Aransas Migratory Waterfowl Refuge, of approximately 46,000 acres situated on the shores of the Gulf of Mexico in Aransas County, Tex., has been used up to this time for grazing purposes but is now dedicated to the conservation of migratory waterfowl and incidentally of other valuable species of wildlife.

For the Back Bay Migratory Waterfowl Refuge, in Princess Anne County, Va., one of the greatest concentration points on the eastern seaboard of waterfowl in their fall migrations, approximately 3,800 acres of land and extensive bodies of intermingled water were approved for purchase. To this original nucleus will be added other lands equally valuable and essential to a well-rounded-out refuge project.

In the Charles Sheldon Antelope Refuge, Nev., which was established by Executive order of December 21, 1935, approximately 18,000 acres of privately owned lands so distributed as to control the water resources essential to the antelope that frequent it are being acquired. Privately owned lands controlling the water resources for antelope on the Hart Mountain Game Range, Oreg., also are in process of acquisition by purchase.

The nucleus for the Patuxent Research Refuge, Md., originally acquired by the Resettlement Administration, was found better suited for wildlife purposes than for the Greenbelt suburban resettlement project, and by Executive order the Biological Survey was given jurisdiction over 2,693 acres. An extension was necessary to bring the unit to maximum usefulness, and 418 acres contained in 8 tracts are being acquired.

TABLE 2.—*Land for refuges and related uses acquired or in process of acquisition during the fiscal year 1937 under the Migratory Bird Conservation Act, with emergency and other funds, by gift, and by Executive order*

| State and county                                               | Refuge                                                          | Under Migratory Bird Conservation Act |                          |         | With emergency and other funds |                          |        | Total   | Acquired other than by purchase | Total  | Acquired in previous years |
|----------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------|--------------------------|---------|--------------------------------|--------------------------|--------|---------|---------------------------------|--------|----------------------------|
|                                                                |                                                                 | Acquired by purchase                  | Pending title conveyance | Total   | Acquired by purchase           | Pending title conveyance | Total  |         |                                 |        |                            |
|                                                                |                                                                 | Acres                                 | Acres                    | Acres   | Acres                          | Acres                    | Acres  | Acres   | Acres                           | Acres  | Acres                      |
| Alaska: Third judicial division                                | Chitina                                                         |                                       |                          |         | 1                              |                          | 1      | 1       |                                 |        |                            |
| Arkansas: Mississippi                                          | Big Lake                                                        |                                       |                          |         | 80                             |                          | 180    | 80      |                                 | 9,299  |                            |
| Arkansas: Desha, Monroe, and Phillips                          | White River                                                     |                                       |                          |         | 22,420                         | 12,927                   | 35,347 | 36,061  | 5,714                           | 64,645 |                            |
| California: Colusa and Glenn                                   | Sacramento                                                      |                                       |                          |         | 10,776                         |                          | 10,776 | 10,776  |                                 |        |                            |
| Delaware: Kent                                                 | Bombay Hook                                                     | 5,120                                 | 6,886                    | 12,006  |                                |                          |        | 12,006  |                                 |        |                            |
| Florida: Levy                                                  | Cedar Keys                                                      |                                       |                          |         |                                |                          |        |         |                                 | 224    |                            |
| Florida: Jefferson, Taylor, and Wakulla                        | St. Marks                                                       | 1,155                                 | 7,199                    | 8,354   | 9,473                          | 1,180                    | 10,653 | 19,007  | 6,155                           | 36,516 |                            |
| Georgia: Charlton, Clinch, and Ware                            | Okefenokee                                                      | 288,417                               | 5,396                    | 293,813 |                                |                          |        | 293,815 | 62                              |        |                            |
| Georgia: Chatham                                               | Savannah River (see also South Carolina)                        | 944                                   |                          | 944     |                                | 1,600                    | 2,544  | 2,544   |                                 | 2,997  |                            |
| Idaho: Jefferson                                               | Camas                                                           | 1,356                                 | 8,831                    | 10,187  |                                |                          |        | 10,187  |                                 |        |                            |
| Idaho: Canyon                                                  | Deer Flat                                                       | 73                                    |                          | 73      |                                |                          |        | 73      |                                 | 10,179 |                            |
| Idaho: Blaine, Cassia, Minidoka, and Power                     | Minidoka                                                        |                                       |                          |         |                                |                          |        | 12,092  | 6,12,092                        | 13,240 |                            |
| Idaho: Bannock                                                 | Pocatello, Biological Survey Supply Depot                       | 1                                     | 1                        | 2       |                                |                          |        | 2       |                                 |        |                            |
| Illinois: Mason                                                | Chautauqua                                                      |                                       |                          |         |                                |                          |        |         |                                 |        |                            |
| Illinois: Carroll, Jo Davies, Rock Island, and Whiteside       | Upper Mississippi (see also Iowa, Minnesota, and Wisconsin)     |                                       |                          |         | 5                              | 2,203                    | 4,208  | 2,208   |                                 | 2,198  |                            |
| Iowa: Kossuth                                                  | Union Slough                                                    |                                       | 864                      | 864     |                                |                          |        |         |                                 | 19,630 |                            |
| Iowa: Allamakee, Clayton, Clinton, Dubuque, Jackson, and Scott | Upper Mississippi (see also Illinois, Minnesota, and Wisconsin) |                                       |                          |         |                                |                          |        |         |                                 | 20,827 |                            |
| Louisiana: Plaquemines                                         | Delta                                                           | 29,966                                | 4,073                    | 34,039  |                                |                          |        |         |                                 |        |                            |
| Louisiana: Cameron                                             | Lacassine                                                       | 17                                    | 8,107                    | 8,124   |                                |                          |        |         |                                 | 1,408  |                            |
| Louisiana: Do                                                  | Sabine Lake                                                     |                                       |                          |         |                                |                          |        |         |                                 |        |                            |
| Maine: Washington                                              | Moosehorn                                                       | 684                                   | 10,609                   | 11,293  |                                |                          |        |         |                                 |        |                            |
| Maryland: Anne Arundel and Prince Georges                      | Patuxent                                                        |                                       | 418                      | 418     |                                |                          |        |         |                                 | 3,111  |                            |
| Michigan: Schoolcraft                                          | Seney                                                           | 3,036                                 | 41,906                   | 44,942  | 826                            | 13,982                   | 14,808 | 59,750  |                                 |        |                            |

[illegible]

See footnotes at end of table.

TABLE 2.—Land for refuges and related uses acquired or in process of acquisition during the fiscal year 1937 under the Migratory Bird Conservation Act, with emergency and other funds, by gift, and by Executive order—Continued

| State and county                                            | Refuge                                                      | Under Migratory Bird Conservation Act |                          |         | With emergency and other funds |                          |         | Acquired other than by purchase | Total     | Acquired in previous years |
|-------------------------------------------------------------|-------------------------------------------------------------|---------------------------------------|--------------------------|---------|--------------------------------|--------------------------|---------|---------------------------------|-----------|----------------------------|
|                                                             |                                                             | Acquired by purchase                  | Pending title conveyance | Total   | Acquired by purchase           | Pending title conveyance | Total   |                                 |           |                            |
|                                                             |                                                             | Acres                                 | Acres                    | Acres   | Acres                          | Acres                    | Acres   | Acres                           | Acres     | Acres                      |
| South Carolina:                                             |                                                             |                                       |                          |         |                                |                          |         |                                 |           |                            |
| Charleston                                                  | Cape Romain                                                 | 15                                    | 15                       | 15      |                                |                          |         | 15                              | 15        | 59,906                     |
| Jasper                                                      | Savannah River (see also Georgia).                          | 617                                   | 617                      | 617     | 2,015                          | 756                      | 2,771   | 3,388                           | 3,388     | 4,062                      |
| South Dakota:                                               |                                                             |                                       |                          |         |                                |                          |         |                                 |           |                            |
| Bennett                                                     | Lacreek                                                     |                                       |                          |         | 3,962                          | 81                       | 234,043 | 4,043                           | 4,043     | 5,320                      |
| Charles Mix                                                 | Lake Andes                                                  |                                       |                          |         | 2                              | 18                       | 220     | 20                              | 20        | 343                        |
| Brown                                                       | Sand Lake                                                   |                                       |                          |         | 4,401                          | 1,294                    | 234,695 | 5,695                           | 5,695     | 14,038                     |
| Day                                                         | Waubay                                                      | 268                                   | 40                       | 308     |                                |                          |         | 308                             | 308       | 2,326                      |
| Tennessee: Lake and Obion                                   | Lake Isom                                                   |                                       |                          |         |                                | 1,402                    | 21,402  | 1,402                           | 1,402     | 20                         |
| Texas:                                                      |                                                             |                                       |                          |         |                                |                          |         |                                 |           |                            |
| Aransas and Refugio                                         | Aransas                                                     |                                       | 45,917                   | 45,917  |                                |                          |         |                                 |           |                            |
| Bailey                                                      | Muleshoe                                                    | 2,155                                 |                          | 2,155   | 2,214                          | 1,440                    | 23,654  | 5,809                           | 5,809     |                            |
| Utah: Box Elder                                             | Bear River                                                  |                                       | 42                       | 42      |                                |                          |         | 42                              | 42        | 51,793                     |
| Virginia: Princess Anne                                     | Back Bay                                                    |                                       | 3,777                    | 3,777   |                                |                          |         | 3,777                           | 3,777     |                            |
| Washington:                                                 |                                                             |                                       |                          |         |                                |                          |         |                                 |           |                            |
| Spokane                                                     | Turnbull                                                    | 1,963                                 | 10,274                   | 12,237  |                                |                          |         | 12,237                          | 12,237    |                            |
| Pacific                                                     | Willapa Harbor                                              | 548                                   | 1,717                    | 2,265   |                                |                          |         | 2,265                           | 2,265     |                            |
| Wisconsin:                                                  |                                                             |                                       |                          |         |                                |                          |         |                                 |           |                            |
| Brown                                                       | Long Tail Point                                             |                                       |                          |         |                                |                          |         | 6103                            | 103       |                            |
| Buffalo and Trempealeau                                     | Trempealeau                                                 |                                       |                          |         |                                | 5,501                    | 45,501  | 5,501                           | 5,501     | 707                        |
| Buffalo, Crawford, Grant, Lacrosse, Trempealeau, and Vernon | Upper Mississippi (see also Illinois, Iowa, and Minnesota). |                                       |                          |         |                                | 300                      | 7300    | 642                             | 342       | 71,103                     |
| Wyoming: Teton                                              | Elk Refuge                                                  | 5,386                                 | 6,790                    | 12,176  |                                |                          |         | 3,165                           | 15,341    | 104,518                    |
| Total                                                       |                                                             | 446,484                               | 261,069                  | 707,553 | 172,760                        | 264,388                  | 437,148 | 996,864                         | 2,141,565 | (1)                        |

1 National Industrial Recovery Act.

2 Federal Emergency Relief Administration and Resettlement Administration funds.

3 \$1,000,000 fund provided through Executive Order No. 6724, of May 28, 1934.

4 \$950,000 fund, a substitute for Executive Order No. 6724.

5 Acquired by gift.

6 Set aside by Executive order or proclamation.

7 Upper Mississippi River Wildlife and Fish Refuge fund.

8 North Dakota land purchase fund.

9 Revised acreage.

10 In addition to the acreage shown, 3,082 acres are held under lease.

11 Total omitted, as entries in column are for only those refuges on which acquisition work was involved during the year.

NOTE.—1-acre items range from a fraction of an acre to 1.49 acres.

Union Slough Migratory Waterfowl Refuge, in north-central Iowa, while containing only 864 acres, constitutes an important link in the Mississippi Valley flyway. The peculiar nature of the ownership and the relatively high value of the lands involved, situated as they are in a highly developed agricultural section, have presented problems in acquisition, but the project is being consummated with the active cooperation of the State.

### MIGRATORY-WATERFOWL RESTORATION PROGRAM

Progress in the program of migratory-waterfowl restoration has resulted in materially increasing the acreage of suitable land and water habitat. Emphasis this year, however, has been on physical and biological rehabilitation to bring the refuges to their highest carrying capacity for wildlife. Under the guidance of hydraulic engineers water-impoundment structures have been placed on all refuges suitable for flooding. Wildlife technicians have supervised the planting of tons of duck-food plants and of millions of food-bearing trees and shrubs to make the areas further attractive to wildlife. The results have been gratifying and the waterfowl productivity of the many nesting refuges in the Great Plains already has increased three to five times over what it was under natural conditions. Their upland game and fur resources also have been correspondingly built up. It is now demonstrated that methods adopted in the restoration program are a practical success. Reconnaissance surveys over the entire refuge system have shown increased utilization by waterfowl and have demonstrated the need for further acquisition and development of refuge sites at certain gaps in the principal flyways of these migrants.

### REFUGE RESTORATION AND DEVELOPMENT

#### CIVILIAN CONSERVATION CORPS COOPERATION

On the average 24 C. C. C. camps, comprising a total of approximately 4,000 men, were engaged during the year in wildlife-conservation work on 27 refuges in breeding grounds, along migration routes, and in wintering grounds of migratory birds, as well as on ranges of big game and in areas that produce fur-bearing animals.

One camp supervised by the Survey developed a research center at Lake Okoboji, Iowa, for the cooperative study of wildlife problems; a large detachment from a Forest Service camp built fresh-water ponds and improved administrative facilities at the Cape Romain Refuge in South Carolina; and another detachment began cooperative work with the Utah Fish and Game Department for impounding fresh water at the mouth of the Weber River to eliminate waterfowl mortality from botulism in the vicinity of the Bear River Refuge.

New camps were established on the following refuges: The Sacramento Refuge, Calif., known to many sportsmen and naturalists as the Spalding Ranch; the Okefenokee wilderness area in Georgia, where a tract of approximately 300,000 acres has recently been made a refuge; Tamarac Refuge, Minn., a beautiful wooded bird haven; Medicine Lake Refuge, in the plains of eastern Montana; and Lacreek Refuge, unique in an arid section of South Dakota because of its wonderful supply of spring water.

The vital relationship of the conservation, use, and control of water to the successful functioning of refuges has received special attention in the work of the year. Biologists have cooperated with engineers to plan the dams, dikes, and water-control structures that have been built by C. C. C. enrollees to restore the areas to a condition most favorable for wildlife. Each area was studied to determine its peculiar deficiencies and the special measures required to overcome them. Along the eastern coast, fresh-water ponds were provided as they are a great attraction where salt water is predominant. In coastal marshes, water levels were stabilized to the great benefit of vegetation and dependent animal life; and in dry areas of the West, reservoirs were constructed to conserve the spring run-off for maintenance of nesting and feeding marshes.

In addition to improving water facilities the C. C. C. job has included the construction of nesting islands ranging from three-quarters of a mile in length down to the small muskrat-lodge type. Some are grassy for duck and shore-bird nesting; some are gravelly landing bars for geese; and a few are rocky to attract gulls, terns, cormorants, and other birds. Not only do these islands furnish ideal nesting sites, relatively safe from predators, but they serve also as wave breakers to protect shore lines from erosion and favor the growth of aquatic food plants.

The planting in tremendous quantity of marsh and aquatic vegetation and of shrubs, vines, and soil-binding grasses has also been an important accomplishment, both in increasing wildlife productivity on refuges and in decreasing soil erosion. During the year, more than a million trees were set out by C. C. C. enrollees, primarily to provide windbreaks and wildlife cover, and secondarily to landscape refuge headquarters sites.

To supplement the natural vegetative cover, which on many of the refuges has not yet recovered from long periods of unrestrained erosion, hundreds of shelters of various types were erected for winter protection of upland game birds and mammals. Many were of the lean-to type, others in the form of tepees, and some of the open-brush-pile variety. Food and cover-producing shrubs and vines planted nearby will be serviceable later.

To facilitate refuge management, truck trails, bridges, lookout towers, fire lanes, telephone lines, small headquarters and utility buildings, and seed- and tuber-storage cellars have been constructed, and to keep out livestock and prevent trespass, fences and boundary markers have been erected. The gathering and planting of aquatic seeds and tubers, stream and lake-bank protection, soil conservation, general clean-up, and salvaging of old buildings are other contributions of the C. C. C. enrollees to the program of refuge improvement.

The third year of C. C. C. activities under technical supervision of field agents of the Bureau finds refuge areas showing a remarkable physical transformation, especially in the West, where now, covered with mantles of protective vegetation and having stabilized water areas, they stand out in marked contrast to the eroded dry lands that surround them. The following tabulation presents in detail the varied nature and the extent of the accomplishments by the C. C. C. camps during the year, which are exclusive of work done by regular employees on other refuges:

#### Structural improvements:

|                                                 |              |          |
|-------------------------------------------------|--------------|----------|
| Bridges:                                        |              |          |
| Foot                                            | number       | 4        |
| Vehicle                                         | do           | 33       |
| Buildings:                                      |              |          |
| Lookout towers                                  | do           | 9        |
| Bathhouses                                      | do           | 3        |
| Cabins, patrol houses, and dwellings            | do           | 21       |
| Garages, barns, and service and other buildings | do           | 98       |
| Cribbing, including filling                     | cubic yards  | 1, 110   |
| Fences                                          | rods         | 211, 395 |
| Guardrails                                      | do           | 284      |
| Power lines                                     | miles        | 10       |
| Sewage and waste-disposal systems:              |              |          |
| Disposal beds                                   | square yards | 2, 640   |
| Disposal tanks and pools                        | number       | 4        |
| Sewer lines                                     | feet         | 5, 973   |
| Telephone lines                                 | miles        | 89       |
| Water-supply systems:                           |              |          |
| Open ditches                                    | feet         | 2, 650   |
| Pipe or tile lines                              | do           | 16, 145  |
| Springs, water holes, small reservoirs          | number       | 9        |
| Wells, including pumps and pumphouses           | do           | 6        |
| Other improvements:                             |              |          |
| Camp fireplaces                                 | number       | 11       |
| Cattle guards                                   | do           | 27       |
| Portals                                         | do           | 7        |
| Signs, markers, and monuments                   | do           | 952      |
| Stone walls                                     | rods         | 82       |
| Table and bench combinations                    | number       | 20       |
| Miscellaneous                                   | do           | 53       |

#### Transportation improvements:

|                     |       |         |
|---------------------|-------|---------|
| Roads:              |       |         |
| Foot trails         | miles | 7       |
| Truck trails        | do    | 380     |
| Quarrying limestone | tons  | 19, 647 |
| Crushing            | do    | 18, 189 |
| Hauling             | do    | 21, 505 |

#### Erosion control:

|                                 |              |          |
|---------------------------------|--------------|----------|
| Stream and lake bank protection | square yards | 91, 996  |
| Treatment of gullies:           |              |          |
| Bank sloping                    | do           | 154, 006 |
| Seeding and sodding             | do           | 5, 175   |
| Tree planting                   | do           | 1, 000   |
| Check dams                      | number       | 18       |
| Terracing, seeding, and sodding | square yards | 18, 930  |
| Sheet erosion planting          | acres        | 10       |
| Miscellaneous                   | man-days     | 1, 807   |

#### Fire suppression and fire-hazard reduction:

|                       |       |         |
|-----------------------|-------|---------|
| Fighting forest fires | do    | 10, 221 |
| Firebreaks            | miles | 187     |

## Fire suppression—Continued.

|                        |          |        |
|------------------------|----------|--------|
| Fire-hazard reduction: |          |        |
| Roadside               | miles    | 3      |
| Other                  | acres    | 1, 330 |
| Fire prevention        | man-days | 776    |

## Recreational and demonstration area development:

|                                            |              |         |
|--------------------------------------------|--------------|---------|
| Beach improvement                          | acres        | 4       |
| Fine grading, road slopes, etc.            | square yards | 52, 774 |
| General clean-up                           | acres        | 3, 868  |
| Landscaping, undifferentiated              | do           | 60      |
| Obliteration:                              |              |         |
| Roads                                      | miles        | 3       |
| Borrow pits, dumps                         | man-days     | 353     |
| Parking areas and parking overlooks        | square yards | 9, 655  |
| Public camp- and picnic-ground development | acres        | 24      |
| Razing undesirable structures              | number       | 4, 995  |
| Soil preparation                           | acres        | 3, 334  |
| Walks, concrete, gravel, cinder, etc.      | feet         | 2, 316  |

## Water conservation:

|                        |              |             |
|------------------------|--------------|-------------|
| Clearing and cleaning: |              |             |
| Channels               | square yards | 1, 156, 598 |
| Reservoir sites        | acres        | 769         |

## Dams, impounding and diversion:

|                                             |              |             |
|---------------------------------------------|--------------|-------------|
| Concrete                                    | cubic yards  | 6, 795      |
| Fills, earth                                | do           | 220, 199    |
| Fills, rock                                 | do           | 4, 551      |
| Masonry                                     | do           | 1, 183      |
| Riprap                                      | square yards | 8, 436      |
| Steel                                       | pounds       | 79, 475     |
| Excavations, earth                          | cubic yards  | 77, 076     |
| Excavations, rock                           | do           | 2, 155      |
| Levees, dikes, and jetties                  | do           | 1, 799, 356 |
| Excavation of channels, ditches, and canals | do           | 687, 500    |
| Lake and pond development                   | man-days     | 31, 033     |
| Pipe lines and conduits                     | feet         | 2, 486      |
| Riprapping or paving:                       |              |             |
| Rock or concrete                            | square yards | 62, 503     |
| Brush or willows                            | do           | 35, 526     |
| Water-control structures, other than dams   | number       | 57          |
| Concrete or masonry                         | cubic yards  | 2, 232      |
| Wood                                        | feet         | 269, 796    |

## Wildlife habitat improvement:

|                                      |          |          |
|--------------------------------------|----------|----------|
| Field planting or seeding (trees)    | acres    | 31       |
| Food and cover planting and seeding  | do       | 5, 507   |
| Nurseries                            | man-days | 8, 193   |
| Moving and planting trees and shrubs | number   | 953, 906 |
| Seed collection                      | pounds   | 50, 126  |
| Seeding and sodding                  | acres    | 58       |

## Other activities:

|                                            |          |         |
|--------------------------------------------|----------|---------|
| Emergency work:                            |          |         |
| Wildlife feeding                           | man-days | 291     |
| Other work (floods, etc.)                  | do       | 21, 343 |
| Eradication of poisonous or pest plants    | acres    | 1, 435  |
| Insect pest control                        | do       | 1, 012  |
| Preparation and transportation of material | man-days | 31, 974 |
| Reconnaissance and investigation           | do       | 3, 196  |
| Rodent control                             | acres    | 18, 067 |
| Surveys:                                   |          |         |
| Grade lines                                | miles    | 350     |
| Lineal                                     | do       | 410     |
| Topographic                                | acres    | 13, 332 |
| Type                                       | do       | 32, 775 |
| Other                                      | man-days | 4, 946  |

## COOPERATION OF WORKS PROGRESS ADMINISTRATION

Allotments of \$1,628,926 by the W. P. A. enabled the Survey to carry on projects designed to provide employment for those in need of relief and at the same time to conserve water and wildlife, check floods and erosion, increase fur production, provide stable water supplies, and develop waterfowl refuges in the following States: North Dakota, Montana, South Dakota, Nebraska, Louisiana, Oklahoma, Michigan, Wisconsin, and Wyoming. Work was done on such important wildlife-restoration projects as the 75 easement refuges in North Dakota and Montana, the Souris River refuges in North Dakota, the Red Rock Lakes refuge in Montana, the Delta refuge in Louisiana, and the Seney refuge in Michigan.

The Long Lake Migratory Bird Refuge in Burleigh County, N. Dak., one of the easement refuges, exemplifies the type of work thus made possible and the results obtained. Although part of this once excellent waterfowl area was purchased by the Biological Survey in 1932, it was most of the time a dry, barren lake bed until extensive development was undertaken after W. P. A. labor and funds became available. Long Lake is again functioning as a nest-

ing haven for migratory waterfowl. Three large dikes and several smaller ones have been constructed and have caught a large part of the run-off from winter snows and spring rains. For the first time in years this 14,000-acre marsh area was covered with water, and ducks returning from the South last spring settled there by the hundreds. The dikes now provide three water-holding units, two of which are already excellently suited for waterfowl nesting. During dry spells, the spring run-off can be confined to these two units, thus assuring the birds plenty of water at all times. This year, these two units had a depth of 4 feet of water and their overflow filled the remaining unit to a depth of  $1\frac{1}{2}$  feet.

If for no other reason than the conservation of water, the W. P. A. projects sponsored by the Biological Survey on its bird refuges in the West are distinctly advantageous to the communities in which they are located and are well worth their cost. In addition, in accomplishing their prime purpose, they are at the same time providing work for the needy and improving wildlife conditions.

On the Delta Migratory Waterfowl Refuge, a 48,735-acre wintering haven for waterfowl in Plaquemines Parish, La., that is also representative of the refuges under development, crews of the W. P. A. have made outstanding progress. Inaccessibility of the area made it necessary to obtain four "quarterboats" from the United States district engineers on which to house the men working on the refuge. Though no development work had been undertaken earlier, a great deal has been accomplished since the advent of the W. P. A. crews in August 1936, including the razing of numerous unserviceable buildings at the old quarantine station, the construction of new ones, and the repair of others from salvaged materials, construction of a sea wall, a wharf, and fences, posting boundaries, and landscaping.

#### COOPERATION OF NATIONAL YOUTH ADMINISTRATION

Through cooperation of the N. Y. A. several hundred young men on its rolls, and working under its rules and regulations, began this year to receive preliminary training in wildlife management under the direct supervision of the Biological Survey on many of the Bureau's bird refuges. Their duties consist of observing wildlife, making nest and brood studies, planting for food and cover, and doing other types of work for which they are found qualified. All those selected were first interviewed personally by members of the Bureau, and each month all have been furnished printed and mimeographed bulletins, instruction sheets, and other aids. They are required to prepare weekly reports on the area on which they work, the reports are carefully checked, and records are made for future reference. Letters are written as necessary advising of errors in reporting, answering the many inquiries made, and encouraging the writers to continued enthusiasm in their wildlife work.

The training given has been along the lines of conservation, wildlife management, and identification of native plants and animals, and the young men have made great advancement and improvement in the work since its inception in January. Some examples of individual assignments are: Patrol of the refuge areas; submission of weekly reports on the state of structures, signs, buildings, plant and animal life and on water conditions; observing and reporting on the activities of predators; planting tree and shrub seedlings; destroying nests of crows; finding, staking, and watching duck nests; acting as unofficial game warden (reporting violations to the Biological Survey agents in charge of the refuge); and cultivating and caring for plantings made on the refuge.

This cooperative work is mutually beneficial to the Bureau and to the young men: To the Bureau it is valuable not only in the work accomplished, but also from a public-relations standpoint, as the interest and enthusiasm of this group of workers is resulting in a more general interest in and knowledge of wildlife conservation in the communities in which they reside. For the young men thus employed it is providing much-needed work and is giving them training in wildlife-management practices that may be useful in later life.

#### ENGINEERING WORK ON REFUGES

For the purpose of facilitating the supervision and direction of the engineering work on the Biological Survey's migratory-waterfowl restoration projects, the United States has been divided into three districts—the eastern, central, and western—with an engineer from the Bureau of Agricultural

Engineering in charge of each. The work in all three districts has included surveying, topographic mapping, preparation of plans for the construction of water-control structures, and actual construction work. Among outstanding accomplishments were the completion of a water-control structure on Jack Creek in the Cape Romain Refuge, S. C.; preparing and letting the contract for constructing dikes and control structures on the Mud Lake Refuge, Minn.; surveying the entire Sabine Refuge, La., and preparing plans for the stabilization of the water levels in one unit; completion of the east levee on the Squaw Creek Refuge, Mo., by C. C. C. labor; construction of a dam and control structure on the Talcot Refuge, Minn.; completion of construction of a dike and water-control structures on unit 1 of the Seney Refuge, Mich.; building by C. C. C. forces of dam 357, with control structures, on the Lower Souris Refuge, N. Dak.; and preparation of plans for diverting the Little White River into pools on the Lacreek Refuge, S. Dak.

In addition, topographic surveys and complete engineering plans necessary for letting bids have been made on the Savannah River Refuge, in Georgia and South Carolina; Boulder Canyon Refuge, in Arizona and Nevada; Rice Lake Refuge, Minn., Delta Refuge, La.; Bombay Hook Refuge, Del.; and Mattamuskeet Refuge, N. C. Through a cooperative arrangement with the C. C. C., water-control, conservation, and development works are in process of construction on the Malheur Refuge, Oreg., Tule Lake and Sacramento Refuges, Calif., and Medicine Lake Refuge, Mont.

Other important engineering activities for the year include the filing of water rights on all North Dakota refuges and on the Medicine Lake Refuge, Mont.; release of water from the large storage dam on the Upper Souris Refuge, N. Dak., which was supervised by the Souris River watermaster, a hydraulic engineer employed by the Biological Survey; supervision and distribution of the spring run-off of the Souris River; and completion of an engineering report for the National Resources Committee on the Bosque del Apache Refuge, N. Mex.

Engineering plans were made during the year in a cooperative attempt of the Bureau of Biological Survey and the Utah Fish and Game Commission to eliminate a natural death trap for water birds on Great Salt Lake, at the mouth of the Weber River in Utah. In the past thousands of birds have perished here annually from botulism, a disease that prevails in these alkaline flats during periods of low water. Construction work is already under way through the use of a large C. C. C. detachment from the Bureau's Bear River camp.

#### HABITAT RECONNAISSANCE AND IMPROVEMENT

Water-impoundment structures erected during the year serve to increase the production of aquatic food plants on many refuges as well as to insure an ample supply of water on nesting areas to accommodate young birds during the flightless stage. To supplement food and cover plantings attractive to birds on refuges that were deficient in this respect, more than 300,000 pounds of seeds, tubers, rootstalks, and other vegetative parts were gathered on other refuges where the stand was ample for the purpose. Much was accomplished also in eradicating certain species that retard or prevent the growth of recognized waterfowl food and cover plants. Noteworthy was an operation at the Mattamuskeet Refuge, N. C., where more than 2,500 acres of dense cattails were cut at the time when the plant's energy was being expended in producing fruiting heads. The few stalks that reappeared were again cut, after which the rootstalks perished. The disappearance of cattails was followed by a dense growth of the highly desirable three-square bulrush.

Practically every refuge has some sections of value to the local upland game birds and mammals. Tracts unsuited to the nesting requirements of waterfowl are utilized for growing food plants for them and for food and cover for upland game. Development of these areas includes the planting of wheat, corn, millet, milo, clover, rye, barley soybeans, alfalfa, and similar crops. Many of the grainfields are harvested to supply seed for future planting and supplementary winter food for the birds.

Approximately 5,500,000 trees and shrubs suitable for food and cover and tolerant of local conditions were planted during the year on refuges in the Great Plains region, where such growth has been destroyed by recent years of drought and overgrazing. About two-thirds of this total was temporarily set out in nurseries and the remainder in their permanent locations according to the improvement plans.

While planting is being undertaken primarily to provide food and cover, every effort is being made to control wind and water erosion by use of appropriate vegetation. Many miles of newly constructed dikes have been sown also to soil- and sand-binding grasses.

The fact that islands are relatively free from predators renders them attractive as resting and nesting sites to many species of water birds. For this reason, in its efforts to improve conditions for wildlife on its refuges, the Bureau has constructed many artificial islands, which not only have attracted migratory waterfowl but also nesting colonies of other species of water birds. Cormorants, pelicans, and ring-billed and California gulls have colonized on several islands on the Bear River Refuge, Utah; pelicans and gulls have bred in large numbers on an island on the Malheur Refuge, Oreg.; and cormorants and terns were noted on the islands of the Waubay Refuge, S. Dak., soon after their completion.

To provide for the needs of the tree-nesting species of waterfowl, including wood ducks and goldeneyes, which find a dearth of suitable cavities in trees, a number of nesting boxes have been constructed and placed on many of the Bureau's refuges. On Waubay Refuge, S. Dak., two of three such boxes were this year occupied by goldeneyes. The fact that only one previous nesting record has been established for this species in South Dakota demonstrates their value.

To prevent interference with the production of waterfowl and other game birds, intensive work was undertaken on many refuges for the control of predators in no immediate danger of extermination. Major activities were against skunks, which were found to destroy 30 percent of the nests on the Lower Souris Refuge in 1936. Other more or less destructive nest robbers are bull snakes, coyotes, foxes, raccoons, and crows.

#### EASEMENT REFUGES

The phase of the migratory-waterfowl restoration program instituted in North Dakota in 1935 with the establishment of 32 easement refuges was this year extended to Montana. The success of the 1936-37 program, as well as of the first year program, has been primarily due to the splendid cooperation of the various counties and other political subdivisions in lending their facilities and equipment and of landowners and other conservation-minded residents who gratuitously granted perpetual easements to the sites and otherwise lent their support and assistance. As a result of this cooperation there are now 75 easement refuges in these two States, both of which contain important waterfowl breeding grounds. Of the aggregate of the 118,777 acres composing these 75 refuges, rights to 110,154 acres were thus acquired without cost to the Government (table 3).

All development work on these easement projects has been done by W. P. A. relief labor. Of the W. P. A. funds allotted to the Bureau for migratory-waterfowl conservation, a large part was expended on this type of project. Since the cost of procuring the sites was negligible, and since great savings were effected by the use of borrowed equipment, practically all the available funds passed directly into the hands of deserving relief clients.

The new projects added during the year were selected primarily for their value as waterfowl and other wildlife refuges, secondarily as water-conservation projects, and lastly as recreational areas. The availability of relief labor and the need for work projects were also taken into consideration. Every effort was made so to locate the proposed projects with reference to others already established as to avoid a concentration of refuges in any one section of a State.

The heavy rainfall and run-off during the spring of 1937 provided an adequate test for the water-control structures on established easement refuges and demonstrated their worth in water conservation and as waterfowl projects. It was estimated in the fall of 1936 that there were about 2,000,000 birds on the 71 projects in North Dakota.

The extension of the easement-refuge system into Montana did not actually get under way until April 15, and the four projects in that State are still in the construction stage. Some difficulty was experienced in getting started, primarily because the program was entirely new to Montana residents and required some educational work. Further, Montana laws lend themselves less easily to this purpose than those of North Dakota, where the State legislature authorized and directed the several counties in which Biological Survey refuge projects are located to exempt from taxation all inundated refuge lands and to waive recording and filing fees for necessary documents.

TABLE 3.—*Bird refuges established in North Dakota and Montana by gratuitous easements to the Federal Government*

| State and refuge     | County               | Area         | State and refuge           | County           | Area              |
|----------------------|----------------------|--------------|----------------------------|------------------|-------------------|
| <b>North Dakota:</b> |                      | <i>Acres</i> | <b>North Dakota—Contd.</b> |                  | <i>Acres</i>      |
| Appert Lake.....     | Emmons.....          | 1, 120       | Lost Lake.....             | McLean.....      | 960               |
| Ardock Lake.....     | Walsh.....           | 1 3, 025     | Maple River.....           | Dickey.....      | 1, 120            |
| Billings Lake.....   | Cavalier.....        | 760          | Minnewastena.....          | Benson.....      | 160               |
| Bone Hill Creek..... | LaMoure.....         | 640          | Oen Lake.....              | Ward.....        | 640               |
| Buffalo Lake.....    | Pierce.....          | 2, 073       | Painted Woods.....         | McLean.....      | 957               |
| Camp Lake.....       | McLean.....          | 1, 313       | Pioneer Lake.....          | Walsh.....       | 640               |
| Canfield Lake.....   | Burleigh.....        | 458          | Pleasant Lake.....         | Benson.....      | 986               |
| Charles Lake.....    | Hettinger.....       | 800          | Prairie Lake.....          | Nelson.....      | 320               |
| Chase Lake.....      | Stutsman.....        | 1 3, 484     | Pretty Rock.....           | Grant.....       | 800               |
| Cherry Creek.....    | McKenzie.....        | 400          | Rabb Lake.....             | Rolette.....     | 262               |
| Clearwater.....      | Mountrail.....       | 187          | Rock Lake.....             | Towner.....      | 7, 840            |
| Clouds Lake.....     | Sargent.....         | 840          | Rose Lake.....             | Nelson.....      | 1, 280            |
| Cottonwood Lake..... | McHenry.....         | 1, 013       | School Section Lake.....   | Rolette.....     | 680               |
| Dakota Lake.....     | Dickey.....          | 2, 520       | Shell Lake.....            | Mountrail.....   | 1, 677            |
| Flickertail.....     | Emmons.....          | 640          | Shenoyenne Lake.....       | Sheridan.....    | 838               |
| Florence Lake.....   | Burleigh.....        | 670          | Sibley Lake.....           | Griggs.....      | 1, 091            |
| Half-way.....        | Stutsman.....        | 160          | Silver Lake.....           | Benson.....      | 2, 960            |
| Hiddenwood.....      | McLean.....          | 568          | Snyder Lake.....           | Towner.....      | 992               |
| Hobart Lake.....     | Barnes.....          | 1, 791       | Springwater Lake.....      | Emmons.....      | 640               |
| Hutchinson.....      | Kidder.....          | 458          | Stewart Lake.....          | Slope.....       | 1, 920            |
| Johnson Lake.....    | Nelson and Eddy..... | 1, 608       | Stoney Slough.....         | Barnes.....      | 2, 000            |
| Kellys Slough.....   | Grand Forks.....     | 1 1, 490     | Storm Lake.....            | Sargent.....     | 1 682             |
| Lac aux Mortes.....  | Ramsey.....          | 1 5, 338     | Sunburst.....              | Emmons.....      | 495               |
| Lake Elsie.....      | Richland.....        | 645          | Tobacco Garden.....        | McKenzie.....    | 120               |
| Lake George.....     | Kidder.....          | 3, 107       | Tomahawk.....              | Barnes.....      | 440               |
| Lake Ilo.....        | Dunn.....            | 2, 460       | White Lake.....            | Slope.....       | 960               |
| Lake Moraine.....    | Burleigh.....        | 320          | Wildfang.....              | Burleigh.....    | 560               |
| Lake Nettie.....     | McLean.....          | 1, 800       | Wild Rice.....             | Sargent.....     | 240               |
| Lake Oliver.....     | Oliver.....          | 640          | Willow Lake.....           | Rolette.....     | 2, 836            |
| Lake Patricia.....   | Morton.....          | 1, 280       | Wintering Lake.....        | McHenry.....     | 400               |
| Lake Susie.....      | McLean.....          | 480          | Wood Lake Marsh.....       | Benson.....      | 545               |
| Lake Tewaukan.....   | Sargent.....         | 1 4, 548     | Yanktonai.....             | McLean.....      | 800               |
| Lake Zahl.....       | Williams.....        | 3, 497       | <b>Montana:</b>            |                  |                   |
| Lamps Lake.....      | Nelson.....          | 320          | Black Coulee.....          | Blaine.....      | 1, 160            |
| Legion Lake.....     | Mountrail.....       | 600          | Hewitt Lake.....           | Phillips.....    | 1, 200            |
| Little Goose.....    | Grand Forks.....     | 360          | Lake Mason.....            | Musselshell..... | 4, 200            |
| Little Lake.....     | Emmons.....          | 480          | Thibadeau.....             | Hill.....        | 3, 601            |
| Long Lake.....       | Burleigh.....        | 1 18, 005    |                            |                  |                   |
| Lords Lake.....      | Bottineau.....       | 1, 877       | <b>Total.....</b>          |                  | <b>1 118, 777</b> |

<sup>1</sup> Including acreage acquired by purchase in 7 refuges in North Dakota as follows: Ardock Lake, 291; Chase Lake, 500; Kellys Slough, 690; Lac aux Mortes, 8; Lake Tewaukan, 80; Long Lake, 7,052; and Storm Lake, 2; total, 8,623 acres.

#### PROVIDING FOR MAINTENANCE AND PATROL

The acquisition of more than 2,000,000 acres of refuge land during the year has resulted in greatly increased responsibility and activity in maintenance and patrol. Practically all waterfowl refuges now containing sufficient acreage for administration have been provided with a skeleton staff of managers and technical assistants. Additional men have been employed for supervision, administration, and patrol, and, in some cases, for suppressing predators. With the constant supervision and guidance of the older, more experienced men, the organization has been maintained on a highly coordinated basis and at a minimum cost.

The increased refuge acreage has also resulted in proportionately increased expenditures for equipment, including fences and engineering and housing structures. The maintenance program has involved construction of several hundred miles of fence; extensive road, trail, fire, and truck-trail building, repair, and rebuilding; and thousands of yards of riprapping and earth moving for the reinforcement and repair of impoundment dikes and levees. Innumerable lesser undertakings have been necessary to maintain all the areas and have them function for wildlife in full measure.

During the past year the Treasury received \$31,623 chiefly for haying and grazing leases granted locally in order to provide food and water for livestock and limit the fire hazard created by weed and grass growth. During last summer's severe drought the refuges in the Great Plains region provided the only good forage for the livestock on many neighboring farms. An intensive survey was recently begun on all major refuges to ascertain the acreage

under Bureau jurisdiction that can be safely allotted for such public use under permit, in order to realize a maximum of profit and maintain maximum protection for wildlife.

There has been the usual demand for the emergency feeding of wildfowl and upland game birds during the past winter, and many tons of grain have been used on refuge areas, particularly in northern and mountainous sections. An increasing number of upland game and other birds has been noted as a result of these operations.

### ADMINISTRATION OF NATIONAL WILDLIFE REFUGES

At the beginning of the year there were 164 wildlife refuges under the jurisdiction of the Biological Survey, estimated to aggregate 9,943,023 acres. At the close of the year the refuges numbered 231, and the estimated acreage under control or approved for purchase was 11,482,374. Of these refuges 216 are in the United States (7,391,485 acres) and 15 in Alaska, Hawaii, and Puerto Rico (acreage estimated as 4,090,889). These national wildlife refuges may be classified by functions as shown in table 4. In addition the Bureau administers 14 smaller experimental and administrative units (aggregating 9,791 acres) on which wildlife also is protected.

TABLE 4.—*Number and extent of national wildlife refuges administered by the Biological Survey*

| Classification                                     | Number | Acres      |
|----------------------------------------------------|--------|------------|
| Migratory-waterfowl refuges.....                   | 128    | 1,424,403  |
| Refuges for other migratory birds.....             | 54     | 887,734    |
| Wildlife refuges (birds, mammals, and others)..... | 10     | 4,040,531  |
| Refuges chiefly for nongame birds.....             | 28     | 111,479    |
| Big-game preserves and ranges.....                 | 11     | 5,018,227  |
| Total.....                                         | 231    | 11,482,374 |

### BIRD REFUGES

#### WILDLIFE TRENDS ON BIRD REFUGES

The success of the waterfowl-restoration program and the modern game-management practices undertaken by the Biological Survey is already beginning to be manifest in increased wildlife populations on the refuges and their spread over surrounding areas. Species that have not been seen in the vicinity of some refuges for many years are now returning there to breed, to winter, or to rest and feed on their semiannual migrations, sometimes in numbers; and species never before recorded on an area have been noted there within the last few years.

Seven nesting species of birds not previously noted were recorded during the year on the Lower Souris Refuge, N. Dak. These are the Holboell's grebe, great blue heron, greater scaup duck, red-tailed hawk, piping plover, avocet (two were seen in migration in 1936, but they have never before been known to nest here), and common tern. These, together with the 7 additional species recorded for the first time in 1936, make a total of 14 species not recorded as nesting on this refuge before the marsh area was flooded.

No snow or blue geese were noted on the Lower Souris Refuge in 1936, but this year they remained on the area from April 16 to May 18 and reached a peak of approximately 600 birds. The entire diving-duck group showed a decided increase over that of last year; and although the duck migration in general was not so large, the nesting population exceeded that of last year by at least 100 percent.

On the Upper Souris Refuge, N. Dak., some 70 miles upstream from the Lower Souris, the avocet and western grebe nested this year for the first time of record.

The comparatively small-sized Sand Lake Refuge, S. Dak., is proving an outstanding sanctuary for Franklin's gull; and although it is somewhat early at this time to make any definite statement as to the number of these birds using the refuge, it is expected that with the beginning of the harvest season, which

always attracts them by thousands, their numbers will exceed the total of 85,000 present in August 1936. This increase in the number of Franklin's gulls on the Sand Lake Refuge is particularly welcomed by the farmers in the vicinity, since the species is a well-known destroyer of grasshoppers, cutworms, grubs, field mice, crickets, and other plant pests. Several hundred grasshoppers may be consumed in 1 day by a single gull.

Canvasbacks were present in greatly increased numbers on the Bear River Refuge, Utah, during the fall migration. Old-time guides and hunters in the vicinity commented on the fact that they had never before witnessed such a heavy migration of these ducks. Redheads also were unusually abundant but not to the same degree as the canvasbacks.

Shovelers nested this year on the Bombay Hook Refuge, Del., for the first time on record. Fourteen pairs were observed, and eight broods of four to eight each were noted.

On the 4,406-acre Chautauqua Refuge, Ill., it is estimated that there was an increase of 60 percent in the number of visiting ducks during their northward migration over the number present in the same period last year. At the peak of the fall migration more than 400,000 ducks and geese visited the refuge at one time.

A brood of seven young canvasbacks was observed on the P Ranch of the great Malheur Refuge, Oreg.—the first nesting record of this species on the refuge or in its vicinity.

Three species of birds—the common loon, black duck, and cinnamon teal—this year for the first time visited the Crescent Lake Refuge, Nebr., and one nest of the cinnamon teal was discovered. A few pairs of this species were reported to have nested near Whitman, Nebr., as late as 1921, but this is the first definite nesting record in the State for many years. It is also worthy of note that an increase of more than 80 percent in the nesting waterfowl population over that for a similar period last year is reported for this refuge.

Perhaps the most gratifying feature of the year's wildlife recovery is the increase noted in the population of the rare trumpeter swan, which has been restricted to a fraction of its former range and still persists in the United States only on the Red Rock Lakes Refuge, Mont., in Yellowstone Park, and on a few adjacent lakes. Last year's count showed a total of 115 in all these areas, while this year the total was 158, an increase of 43. Ninety of these (39 adult birds and 51 cygnets) were within the boundaries of the refuge. This increase encourages the belief that the Bureau's intensive program of protection, predator control, and nesting-site construction will eventually bring this beautiful bird back from the brink of extinction.

It is impracticable here to report on all the bird refuges administered by the Biological Survey, but a few of the more important details regarding refuges, chosen to represent the various types (that is, breeding, resting and feeding, and wintering) and every major flight lane in the United States, will serve to illustrate the conservation and restoration being accomplished by the refuge system, including necessary technical developments.

#### TULE LAKE REFUGE

The Tule Lake Migratory Waterfowl Refuge, Calif., containing 36,563 acres of the best resting and feeding grounds for ducks and geese in the Pacific Northwest, attracts countless numbers of migratory waterfowl and other birds each spring and fall and many breeding pairs in summer. More than 800,000 waterfowl concentrated on the refuge in November, including 290,000 pintails, 130,000 mallards, and 60,000 redheads.

During the waterfowl- and pheasant-shooting season, hunting was permitted on part of this refuge, and each hunter was required to register and have his equipment checked before entering and to have his bag examined before leaving. This was effective in keeping violations at a minimum and in permitting an accurate count of the birds killed. During the open seasons the 7,035 hunters admitted to the refuge killed 20,811 birds, an average of 2.9 each, including 10,311 ducks (5,429 of them pintails), 9,919 geese (4,239 cackling and 3,459 white-fronted geese), and 441 pheasants.

Most of the development work on this refuge has been done by the C. C. C. camp stationed for nearly 2 years on the nearby Clear Lake Refuge. Last October, however, a detachment was allotted from the Bureau of Reclamation camp. Accomplishments of these two camps included the construction of 3 overnight cabins, a garage (with storeroom and fuel space), a large head-

quarters building, an equipment shed, 2 sewage-disposal tanks, and a lookout tower; the erection of 66 miles of fencing and boundary marking; construction of a dike and other water-control structures, 28 nesting islands, 46 quail shelters, a telephone line, and 10 miles of truck trails; regrading 5 miles of truck trails and surfacing with gravel; general clean-up work on 213 acres and landscaping of 5 acres at the headquarters; collecting 1,255 pounds of seed and 20,000 pounds of rootstocks of aquatic plants; planting 150 acres with food and cover plants; and developing a nursery (including the setting out of 50,000 trees).

#### RED ROCK LAKES REFUGE

The Red Rock Lakes Migratory Waterfowl Refuge, Mont., now containing 26,138 acres, is an area of great scenic beauty high in the Rocky Mountain section of Montana that separates Idaho and Wyoming, approximately 30 miles west of Yellowstone National Park. The efforts of the Biological Survey to preserve and increase the numbers of the rare trumpeter swan, which now makes its home on this refuge and on a few lakes in Yellowstone Park, are meeting with success. During the summer of 1936, a total of 31 swans and 26 cygnets were recorded on and near the refuge, an increase of 10 over the number counted the previous year. A survey made this year in conjunction with the National Park Service shows an even greater increase, the figures being as follows (cygnets shown in parentheses): Yellowstone Park, 38 (26); adjacent to Yellowstone Park, 4 (0); Red Rock Lakes Refuge, 34 (51); adjacent to Red Rock Lakes Refuge, 5 (0); total, 81 adults, and 77 cygnets. Thus there are 33 more of these swans on and near the Red Rock Lakes Refuge than in the similar period of 1936. Unlike other species of waterfowl the swans remaining do not migrate. Each winter between 40 and 50 stay in the small open spring heads at the east end of the refuge, where they are protected from man and predatory animals. Here also they are fed if the winter proves to be unusually severe and natural foods are scarce. During the past winter about 20,000 pounds of grain was supplied, but some of it was eaten by other species wintering there.

Seventeen species of ducks now nest on the refuge, and it is estimated that 20,000 to 30,000 were produced there this year. At the end of June approximately 150,000 concentrated on the refuge and remained there through the molting period. The first nesting record of the avocet for the refuge was established this year, when two pairs raised young.

Approximately 33 percent of the refuge was opened to hunting last fall, when 71 hunters bagged 776 ducks. During this period, the trumpeter swans voluntarily moved to the upper lake region, where they received absolute protection. The hunters cooperated fully in safeguarding this and other protected species.

A crew of W. P. A. relief workers was assigned to this refuge in the latter part of May to do fencing, posting, dam rebuilding, and construction work on headquarters buildings, bridges, roads, trails, and a telephone line.

#### LOWER SOURIS REFUGE

The 58,302-acre Lower Souris Migratory Waterfowl Refuge, N. Dak., is one of the most important of those recently established by the Biological Survey. At different times during the year 196 species of birds were observed there, 10 more than last year. The number of nesting species was increased by 7, which, in addition to the 7 new records for the refuge last year, brings the total nesting species to 101.

Great increases have been noted in the population of several other species of wildlife on the refuge, including sharp-tailed grouse, prairie chickens, Hungarian partridges, deer, and foxes. The foxes have now reached the point where they are objectionable as predators on nesting ducks.

Nesting studies have revealed that whereas in 1936 there was a 54.4-percent hatch of ducks on the refuge, with a 30.4 percent nest destruction by skunks, this year it is estimated that there will be about a 70-percent hatch, with less than 7 percent similar destruction. This great decrease in the loss of nests is due to extensive predator control carried on since November 1—423 skunks alone having been taken, as well as 146 weasels, 41 house cats, 20 minks, and 9 coyotes.

Since October 1, W. P. A. labor has supplemented the work of the C. C. C. camp, and accomplishments of the two have included the planting of food crops on 403 acres and 252,335 trees; partial construction of a large dam across the valley near the refuge boundary, and completion of 2 rubble-masonry plug

dams in the river channel; building 10 miles of truck trails and 80 miles of boundary fence, the latter chiefly by W. P. A. labor; the razing of 44 undesirable structures; and general clean-up work, besides recreational area development and sign and marker construction.

#### MALHEUR REFUGE

The 159,966-acre Malheur Migratory Bird Refuge, Oreg., has revealed unquestionable evidence that the present program for the conservation of the country's wildlife resources is not in vain. Far greater numbers of migratory waterfowl flocked there during the past fall and spring than in corresponding periods in the previous year. The winter-resident waterfowl population was small, for with the water frozen over, temperatures hovering between 0° and -42° F. for more than a month, and the ground covered in many places with deep snow, it was almost impossible for the usual waterfowl population to remain.

The creation of lagoons, ponds, dikes, and canals over the refuge seems to have been an incentive for waterfowl to nest in practically all the meadows and formerly dry fields, to a greater extent than in any previous season within the drought cycle. The canvasback duck was found nesting on the refuge for the first time, and there was an unusually successful hatch of Canada geese. Among other breeding species were the sandhill crane, American egret, long-billed curlew, willet, Wilson's snipe, phalaropes, gulls, terns, grebes, and herons.

The Malheur Refuge is proving a distinct asset to the surrounding community, from its value not only for wildlife production but also for recreation and for regulated haying and grazing. Although relatively few campers visited the refuge this year it was much used by fishermen and picnickers. To encourage and specialize on this type of use, a campground with ample camping facilities is being provided.

Somewhat more than 30,000 animal-months' use for grazing was made of the refuge during the 1936-37 season, and approximately 6,000 tons of hay were cut. In addition herbage on several hundred acres of meadows was mowed and bunched for the use of livestock, and 6,000 bushels of grain were threshed by permittees from about 90 acres of bottom land. Later the grain stubble provided an excellent winter feeding place for geese, ducks, and sandhill cranes.

Two C. C. C. camps stationed on the refuge the entire year and a third established on April 1 made many and varied improvements. The headquarters building group, consisting of an office, residences for the superintendent and a clerk, a service building, a barn, and a pumphouse, was completed; another residence was built and the renovation of the old P Ranch buildings was nearly completed. Other accomplishments included the construction of a lookout tower, 20 bridges, a concrete diversion dam, 95 miles of fencing, 35 miles of telephone lines, 58 miles of truck trails, 12 cattle guards, and 2 reservoirs, besides landscaping, razing undesirable structures, general clean-up work, and marking 116 miles of boundary.

#### CAPE ROMAIN REFUGE

The vast marshes of the 59,921-acre Cape Romain Migratory Bird Refuge, S. C., are giving sanctuary to numerous waterfowl, shore birds, nongame birds, and mammals. With food conditions especially good, about 50,000 ducks, chiefly black ducks, mallards, and wigeons, wintered on the refuge, and pintails were for the first time present in numbers. Rails, which are heavily shot in the vicinity, find sanctuary on the refuge, and nest in the marshes by thousands. Numerous nests of the loggerhead sea turtle were observed along the beaches. Bird Island in the Bull Bay section, which was once washed away, is again building up and is being much used by shore birds. On another small bird key the nesting of a new colony of approximately 5,000 royal terns was outstandingly successful.

Landscaping the headquarters site, which was completed during the year with the aid of C. C. C. personnel from a nearby national-forest camp, included making more than 5,000 cubic yards of earth fill, building concrete steps and walks, and gathering and distributing 6,000 bushels of shells on parking areas and driveways. In addition half a mile of fence was constructed and 2,000 bushels of oystershells were placed along the west side to prevent washing by waves. One tower was painted.

During the past few years the beach on the northeast part of Bull Island has been greatly eroded, but this year jetties were constructed by the C. C. C.

personnel, under the supervision of an experienced engineer. These turned the tide toward building up the beach at a most encouraging rate. The C. C. C. forces have also been engaged in building up to grade a dike that will impound a large pond of fresh water. That this pond will successfully maintain itself by natural rainfall has been evidenced by the fact that it has filled up three times after being drained because of construction necessities. In addition the C. C. C. crew has completed a boathouse and wharf at the Bull Island landing, a dock, garage, and storage building at the landing on the mainland, and considerable work on fire lanes and trails.

#### BEAR RIVER REFUGE

The Bear River Migratory Bird Refuge, Utah, an area of 51,835 acres, is outstanding in the number of birds it produces annually and in the number and variety of other forms of wildlife it protects. There was a marked increase this year in the number of waterfowl frequenting the refuge, and at the peak of migration in September it was estimated that 1,200,000 ducks and geese were concentrated there. Particularly interesting was the increase in the number of canvasbacks, which were present last fall in greater numbers than ever before. Early in December 12,000 whistling swans were on the refuge. With food conditions good, a large number of the birds remained until the complete freeze-up early in January. Three new bird visitors appeared during the spring migration—blue goose, least bittern, and herring gull—bringing to 199 the number of species recorded for the refuge. More birds nested on the refuge than in any previous year since its establishment, and to ascertain their numbers an intensive nesting survey was begun at the end of the year.

In November the 1,316 hunters who registered at the refuge headquarters to hunt on the section open to public shooting took a total of 5,488 ducks and geese of all species, or an average bag of 4.17. Since census records kept for the refuge show that there were approximately half a million ducks and geese there during that month, the kill was only slightly higher than 1 percent. There were few violations of the regulations, and these were of a minor nature. Approximately 2,615 people interested in wildlife conservation visited the refuge in the 3 months April to June.

A zealous attempt was made during the year to gather and care for all birds showing symptoms of botulism (western duck sickness). Daily trips were made over the dikes and into infected parts of the marsh, and sick birds were collected in crates and taken to the "duck hospital," where a total of 6,094 ducks of nine species were treated, of which 3,453, or about 57 percent, recovered. In addition 410 miscellaneous ducks and shore birds were similarly treated.

Improvement and development work undertaken during the year by the C. C. C. camp included maintenance of 37 miles of truck trails and 15,277 square yards of beach line, excavation of earth from channels to permit flooding and to create additional nesting areas, completing a concrete water-control structure, planting 703 small trees and shrubs and collecting 7,000 pounds of seeds, building a garage, a barge, and a sewer line and disposal field, moving 71,255 cubic yards of earth in the construction of dikes, and graveling the parking area, besides doing additional work on the laboratory and duck hospital, on lake and pond development, and on posting 16 miles of boundary.

#### WHITE RIVER REFUGE

Because of its great winter concentrations of birds, the White River Migratory Waterfowl Refuge, Ark., now containing 100,706 acres, is one of the Biological Survey's major refuges. During the latter part of October, mallards, gadwalls, baldpates, green-winged teals, shovelers, and many other species of waterfowl began to appear, and in January, it was estimated that fully 700,000 ducks were wintering there. Coots and many of the shore birds also were observed during the migration periods, double-crested cormorants were present spring and fall, and anhingas were common in summer, as also were American and snowy egrets, wood ibises, little blue herons, and green herons, and great blue herons remained all through the year. White-tailed deer were numerous, as were swamp rabbits, fox squirrels, gray squirrels, minks, raccoons, and otters.

At the beginning of the year there were two C. C. C. camps on the refuge, and in December another camp arrived for construction work on dams, dikes, and levees; clearing areas to be flooded for planting to aquatic vegetation; constructing trails (38 miles) and fire lanes; building six bridges, a head-

quarters equipment building, and three lookout towers; and improving wildlife habitat, fencing, and posting.

Thirteen violators of State game laws apprehended during the year paid fines ranging from \$10 to \$50. During the winter floods of the Ohio and Mississippi and their tributaries, considerable rescue work was done by refuge employees and members of the C. C. C. camps. Using their own motorboats as well as tugboats, barges, and trucks, the C. C. C. boys transported hundreds of refugees to places of safety, and on February 3 one of the camps cooked the meals for 125 refugees near St. Charles.

#### UPPER MISSISSIPPI RIVER REFUGE

The Upper Mississippi River Wildlife and Fish Refuge, extending for 284 miles along the upper Mississippi through four States from Rock Island, Ill., to Wabasha, Minn., now contains 149,543 acres, and with the steady progress being made toward the completion of the 9-foot channel canalization program, it is estimated that the War Department has or will acquire within the authorized limits of the refuge an additional 64,862 acres. This will be available for administration as a part of the refuge, and a further area of 9,716 acres has been or will be acquired by flowage easements.

Development work completed during the year included the posting of approximately 120 miles of exterior boundary (mostly by W. P. A. labor), and the completion of a storage warehouse, garage, and marine railway at Winona, Minn. During the period March 1 to April 15, 253 persons were authorized to trap on a small part of the refuge, and an average of about 36 muskrats was taken by each permittee. There was an increase of about 20 percent in the number of waterfowl hunters on sections opened to shooting during the fall season. Sixty-eight violators of various regulations were apprehended during the year.

#### UPPER SOURIS REFUGE

The Upper Souris Migratory Waterfowl Refuge, N. Dak., comprising 30,958 acres, some 70 miles upstream from the Lower Souris Refuge, provided nesting sites for 12 species of waterfowl, and the avocet and western grebe were recorded as nesting there for the first time. In all, 58 species of birds were reported on the refuge during the year. Most of the artificial nesting islands were entirely covered with the nests of terns, avocets, killdeer, and other shore birds, especially the parts that had been graveled, but the many upland game shelters were not used so much as had been anticipated, possibly because the winter was mild; they were frequented to some extent, however, by Hungarian partridges, sharp-tailed grouse, and ring-necked pheasants.

A park and recreational area being provided just below the large storage reservoir constructed last year, known as Lake Darling, is already much used by outdoor enthusiasts, especially on Sundays. The water seems to be the main attraction here, as the supply had been scanty during recent drought years.

The work of two C. C. C. camps has included construction of telephone lines, dikes, truck trails, and artificial nesting islands, landscaping, riprapping, seed collection, recreational development, posting (the refuge was completely posted during the year), remodeling of headquarters buildings, and fencing (87½ miles were completed).

A crew of W. P. A. workers, assigned to the refuge on November 15, 1936, razed undesirable buildings, cleared land, and constructed duck islands, fish shelters, upland bird shelters, and, in conjunction with the C. C. C. camps, a water-gaging station.

#### SENEY REFUGE

The Seney Migratory Waterfowl Refuge of 74,550 acres, in Michigan, always attractive to wildlife, drew larger numbers than ever this year. Important species of waterfowl nested in more or less abundance on the refuge, several—the baldpate, pintail, green-winged teal, and ring-necked duck—for the first time of record, and others, as well as upland game birds and numerous shore birds were present during the spring migration. Other first-nesting records on the refuge were of the pied billed grebe (100 pairs), horned grebe, eastern least bittern (27 nests in two colonies), and American coot (at least 15 pairs). A total of 170 species were observed as migrants, breeding residents, or winter residents.

The C. C. C. camp completed the dike and water-control structures on unit 1, a fire tower, spillway, and entrance gates, and a public shelter and double fireplace; and remodeled the refuge residence and redecorated all refuge buildings. Other accomplishments were in landscaping, seeding 14 miles of dikes, constructing 7 miles of barbwire fence and 7 miles of telephone line, creosoting 2,134 fence posts, and planting 9,890 willow shoots. In July and August the enrollees expended 4,150 man-days in fire suppression on and near the refuge.

Approximately 3,000 persons interested in wildlife conservation visited the refuge headquarters during the year. Under permit, 600 man-days were spent in berry picking, 1,894 man-days in deer hunting on the western half of the refuge in November, and 600 man-days in grouse and prairie chicken shooting. The hunting took place on lands on which options have been taken but to which title had not yet been transferred.

#### VALENTINE REFUGE

On the Valentine Migratory Waterfowl Refuge, now consisting of 68,032 acres situated in the heart of the Nebraska sand hills and including such well-known and important waterfowl lakes as Dewey, Pelican, Hackberry, Dads, Marsh, and Whitewater, the C. C. C. camp has done much to improve the already good waterfowl conditions. Their accomplishments, supplemented by those of a crew of W. P. A. laborers, which began work in August, include construction of 81½ miles of boundary fence, landscaping and completion of the refuge headquarters buildings (consisting of a residence, administration building, service building, tuber cellar, and bird hospital) at Hackberry Lake, trail and road improvement, relocation of the recreational resort, which included the moving of 14 cabins and the digging of 3 wells, placing 15 miles of telephone posts, constructing 200 miles of fire lanes, building 1 peninsula and several pot holes for the birds, completing work on diversion ditches, and planting seeds, tubers, trees, and shrubs (including the planting of 1,352,000 lining-out stock in the nurseries).

Continued research on the refuge by advanced students of the Division of Conservation and Survey of the University of Nebraska included a survey of the aquatic invertebrates in all the lakes, cover mapping, and a study of algae. Duck-nesting surveys show a fivefold increase over the 1936 season, the most abundant breeders being pintails, mallards, blue-winged teals, canvasbacks, red-heads, ruddy ducks, and gadwalls. Other birds that nested in abundance on the refuge were curlews, avocets, upland plovers, western willets, black terns, coots, rails, gallinules, grouse, and pheasants.

#### MATTAMUSKEET REFUGE

One of the most important goose and swan wintering areas on the Atlantic coast, the 50,466-acre Mattamuskeet Migratory Waterfowl Refuge, N. C., which is on the site of an unsuccessful drainage project, is each year giving more tangible evidence of its value for wildlife. In midwinter it harbored 48,000 Canada geese, about an equal number of ducks of various species, and 15,000 whistling swans, a tremendous increase over the previous year. Approximately 42,000 of the ducks were pintails, and although the refuge is not primarily a nesting area, numerous wood ducks and a few mallards nested there.

Fishing and hunting permits were issued by the State of North Carolina under Bureau supervision to 3,472 fishermen and to 898 waterfowl hunters. Local hunting rules were changed this year to require that an authorized guide be in constant touch with each hunting party, thus minimizing the danger to protected species of birds. In addition to hunters and fishermen, many nature lovers and bird students now visit the refuge.

The C. C. C. camp has made the refuge more attractive to wildlife and facilitated administration. Work accomplished included completion of the administration building and an apartment for the refuge manager, construction of a lookout tower and an all-metal garage, remodeling of an old metal building into a supply house and of a small brick building, which once served as a post office, into a power distribution and oil house, road maintenance and improvement, completion of 27 miles of fencing and boundary marking, and the digging of a 3-mile diversion canal to safeguard cultivated areas. Diligent patrol resulted in the apprehension of eight violators of refuge regulations.

## SAND LAKE REFUGE

During the hot, dry summer of 1936, water levels of the lakes within the Sand Lake Migratory Waterfowl Refuge, S. Dak., now consisting of 19,733 acres, reached an all-time low. Conditions were inviting for the influx of birds during the spring migration and the summer nesting season, even though low water in 1936 had reduced aquatic food plants and cover on areas otherwise suitable for ducklings. During the spring migration 159 species of birds were noted, and in May the number of birds on the refuge was more than six times as great as in the same month last year.

There were 6,000 nests of the economically valuable Franklin's gull on the refuge in June of this year, and during the entire summer of 1936 this species found the refuge an ideal resting place, its numbers increasing steadily until on August 21 they reached about 85,000.

C. C. C. camp accomplishments included construction of an eight-stall equipment shed at the headquarters site, an eight-tank aquatic storage cellar, and a camp shop (from salvaged material); remodeling of the C. C. C. carpentry shop and 2 residence buildings acquired with the refuge; building 66 dams, 14 artificial nesting islands, with a total length of over 10,000 feet, and 51 shelters.

In the summer of 1936, 80 acres along the shores of the lakes were planted to aquatic vegetation, and in the spring the Shelterbelt Division of the Forest Service gave the refuge 1,400,000 lining-out stock, all of which was set out in the nursery, which was enlarged to 22 acres. In addition 836 acres were planted in grain crops, consisting of corn, wheat, barley, oats, rye, and millet.

## BIG-GAME PRESERVES

The program for the establishment of big-game preserves in conjunction with the organization of grazing districts under the Taylor Grazing Act of 1934 resulted in the establishment of two large refuges during the year. The Fort Peck Game Range, Mont., comprising 970,000 acres, was set aside by Executive order of December 11, 1936, and the Hart Mountain Antelope Refuge, Oreg., of 215,516 acres, by Executive order of December 21, 1936. The latter is primarily for antelope and sage grouse, although it harbors also substantial numbers of mule deer. The Nevada section of the antelope range, originally defined in the Executive order of September 6, 1935, was continued in a separate unit as the Charles Sheldon Antelope Range under joint administration of the Departments of the Interior and Agriculture with a slight modification in the provisions of the order, by which greater protection will be afforded the antelope, mule deer, and sage grouse. Progress was made also in pending negotiations for the establishment of upland game refuges on several resettlement areas, although none have actually been so designated.

The total number of big-game animals on fenced preserves administered by the Bureau was 2,359 at the close of the year, as compared with 2,356 a year ago (table 5). Reduced forage caused by severe drought in some sections made it necessary to continue heavy disposals of surplus animals to prevent overgrazing and excessive costs for winter feeding.

## NATIONAL BISON RANGE

The big-game animals on the National Bison Range, Mont., came through an unusually severe winter but showed some loss of flesh. During the spring and early summer 65 buffalo calves were born, and by the end of June, 15 elk calves, 8 bighorn lambs, and several deer fawns had been seen. One hundred and eleven surplus buffalo were disposed of, 81 by donation to Indians of the Flathead and Blackfeet Agencies for use as food. The few beavers in the northern part of the range along Mission Creek have decreased in numbers, partly from having reduced their food supply of deciduous trees and partly from being trapped outside the refuge when moving up and down the creek in search of new dam sites. About 10,000 ducks wintered on Mission Creek, and a considerable number nested there. During the winter 6,000 ducks were fed about 6½ tons of grain by employees of the Bison Range, at Warm Springs, 3 miles west of the range. At times to reach the feeding grounds it was necessary to plow a road through deep snow all the way from the headquarters. The ducks came through the winter with slight losses, only about a dozen having been found dead. Pheasants, which are comparatively numerous, also were fed during severe weather. Predatory animals seem to be under control.

TABLE 5.—*Animals on fenced big-game preserves maintained by the Bureau of Biological Survey*<sup>1</sup>

| Preserve                                              | Buffalo | Elk   | Antelope | Big-horn (mountain sheep) | Deer         |       | Total <sup>2</sup> | Young born in calendar year 1936 <sup>3</sup> |          |                           |
|-------------------------------------------------------|---------|-------|----------|---------------------------|--------------|-------|--------------------|-----------------------------------------------|----------|---------------------------|
|                                                       |         |       |          |                           | White-tailed | Mule  |                    | Buffalo                                       | Antelope | Big-horn (mountain sheep) |
| National Bison Range, Mont.                           | 440     | 4 134 | -----    | 41                        | 4 52         | 4 160 | 827                | 80                                            | -----    | 12                        |
| Fort Niobrara Game Preserve, Nebr. <sup>4</sup>       | 140     | 4 35  | -----    | -----                     | 7            | 2     | 184                | 26                                            | 1        | -----                     |
| Sullys Hill Game Preserve, N. Dak.                    | 23      | 4 39  | -----    | -----                     | 11           | ----- | 73                 | 7                                             | -----    | -----                     |
| Wichita Mountains Wildlife Refuge, Okla. <sup>5</sup> | 344     | 4 241 | 4        | -----                     | 4 686        | ----- | 1,275              | 87                                            | -----    | -----                     |
| Total.....                                            | 947     | 4 449 | 4        | 41                        | 4 756        | 4 162 | 2,359              | 200                                           | 1        | 12                        |

<sup>1</sup> With the exception of those of young born, figures are for June 30, 1937.<sup>2</sup> Including estimates.<sup>3</sup> Young of elk and deer omitted, as in most cases only estimates could be made, but during the calendar year approximately 79 elk calves, 60 fawns of mule deer, and 74 of white-tailed deer were counted on the preserves.<sup>4</sup> Estimated.<sup>5</sup> There are also 123 Texas longhorns on the Wichita Mountains refuge and 10 on the Fort Niobrara preserve, including 25 calves of 1937, 4 of which are in the herd at Fort Niobrara.

The summer of 1936 is reported to have been the hottest for 50 years in that part of the country, and with less than half an inch of rainfall the forage dwindled until the arrival of snow and rains in October. Late disappearance of winter snows had been beneficial to the forage, and the grass made excellent growth until injured by the hot and dry weather later in the season and by grasshoppers, which appeared in the higher parts of the range in vast numbers.

Improvements accomplished by the aid of a C. C. C. camp included needed additions to existing structures, painting all the buildings, erection of two garages and stone portals at the main entrance, considerable revegetation of the range, construction of truck trails, reduction of fire hazards, control of rodents, and eradication of noxious weeds.

With P. W. A. funds an 80 acre exhibition pasture was constructed near headquarters for big-game animals, which can be seen there by the increasing numbers of visitors, for whom a camp has been constructed. A great attraction for them has been a second albino buffalo calf, born in the herd in May. The visitors totaled 1,743 during the year, and the number of automobiles has averaged 15 to 20 on Sundays, and often half that number on other days, some coming from the Atlantic seaboard and the far south.

## ELK REFUGE

Up to last year the ever-pressing problem in caring for the elk that winter on the Elk Refuge, Wyo., had to do with providing ample forage. Recent allotments under a special appropriation for refuge acquisition, however, have made it possible to purchase additional lands. This project is now well under way, and its completion, together with that of certain necessary improvements, will solve the former problem. Herd management will also be greatly facilitated by the elimination of livestock grazing and the erection of a drift fence. The fence will prevent the animals from trespassing on adjacent privately owned ranches, where in the past they have destroyed much feed intended for domestic stock.

There is now, for the first time, surplus hay in stacks at the refuge. This condition resulted partly from the kill by hunters of about 6,000 animals in the herd that winters there and partly from an increase in the available hay and in the former grazing range of the elk, through acquisitions that increased the refuge acreage. The State lessened restrictions on hunting in order to reduce the herd to optimum numbers, as it had increased to 22,000. The hay harvested on the refuge in 1936 totaled 2,523 tons, which, with a carryover of 2,173 tons from 1935, besides an available stock of 228 tons of cottonseed cake,

will suffice for any emergency that may arise next winter and permit the sale of surplus hay before its quality deteriorates.

The present surplus of hay is also partly attributable to the fact that the open fall of 1936 delayed the movement of the elk from the mountains. A December snowfall—of 20 inches in the hills, with only 6 inches on the refuge—started the movement, and on December 20 large numbers of elk began to arrive for their winter's stay on the refuge. The maximum number of elk fed during the season was 4,000, and the State game department fed about 800 on the four feeding grounds it maintains. The elk herd survived the winter in good condition, and only 25 of the animals died on the refuge.

Among other forms of wildlife on the elk refuge were Canada geese, 304 of which were counted at one time last fall, and approximately 1,000 ducks, mostly mallards, which remained until about the 1st of December. About 30 sage grouse were on the refuge during the hay harvest last summer, and a few were again seen in the spring. In September one flock of 21 long-billed curlews was noted, thus far the largest number of that species seen on the refuge at one time. Deer have greatly increased in the section during the last few years, a few wintered on the refuge, and 21 came there in the spring and remained for some time. Thirteen bighorn sheep wintered on an adjacent area, and several moose and two bears have been seen on the refuge.

Improvement work during the year included the erection of a 5½-mile woven-wire drift fence, 6 miles of buck and pole fencing, hay sheds (two completed and eight others in course of construction), and other service buildings, and necessary repairs on a dwelling house to provide quarters for an employee on one of the newly acquired tracts.

#### FORT NIOBRARA GAME PRESERVE

The buffalo and elk on the Fort Niobrara Game Preserve, Nebr., are in good condition, but all the young mule deer received from the Custer State Game Preserve, S. Dak., in 1936, were lost and the antelope fawns obtained in the spring and early summer of 1936 either died from disease or were killed by coyotes, despite every effort to safeguard and raise them to maturity. The coyotes destroyed not only a number of young but also the older antelope kept in a small exhibition pasture. Plans are being made to introduce additional young antelope in the hope that the species can be established here.

Two white-tailed deer fawns were obtained from the Custer Preserve last spring. The Texas longhorns brought from the Wichita Mountains Wildlife Refuge, Okla., in 1936, have become accustomed to their new home, withstood the rigorous winter, and are in excellent condition. The bull and the steer in this small herd have made splendid growth since their transfer, each of the four heifers gave birth to a sturdy calf, and the young animals are growing rapidly. Surplus animals disposed of during the year included 25 buffalo and 12 elk, of which 9 buffalo and 8 elk were donated to the Rosebud Indian Agency, S. Dak., for use as food.

The control of predatory animals constitutes the greatest problem on this preserve, to which they are attracted from the surrounding country by the more abundant food. The protection afforded on the preserve has attracted many fur-bearing animals from outside, and these have greatly increased in numbers under the sanctuary conditions. Especially numerous are skunks and raccoons, though minks and weasels are there in considerable numbers and muskrats have again become plentiful on the ponds.

Ducks, herons, bitterns, rails, and other migratory birds flocked onto the water areas of the preserve last September to obtain the food grown during the summer, and approximately 150 mallards were fed grain during the most severe weather last winter. There were not so many ducks on the preserve, however, as in the previous winter, but more species were represented. Great horned owls were abundant, and eagles wintered on the preserve but did little damage to the ducks, as they fed mainly on rabbits. No quail were seen during the spring, but two large flocks of young pheasants were noted. A few prairie chickens and grouse nested on the area.

There was very little moisture during the winter to relieve drought conditions following an extremely dry fall, and only sufficient spring precipitation to keep the grass alive. Slight grass growth and no seed production was recorded, but on the flat parts of pastures there was a heavy growth of weeds. Grazing conditions were therefore below normal, and as a result of

forage scarcity it will again be necessary to feed hay to the game animals next winter.

The construction by E. C. W. workers of a bridge over the Niobrara River to connect the two big-game pastures was the most important improvement on the preserve during the year. A 125-foot lookout tower was completed at headquarters, and a museum was finished in which there is a creditable display of specimens of mammals, birds, reptiles, and insects found on the preserve and an excellent collection of fossils of the prehistoric mammals that formerly ranged on this area. Other accomplishments with labor provided under the E. C. W. program included improvement of the water-supply system, installation of underground and other power lines, betterment of truck trails and fences, and additional road work. A small detachment of W. P. A. workers was employed during part of the year to complete work begun under the E. C. W. program; also to build a bridge over a small creek, install an irrigation system at headquarters, construct check dams on the preserve, provide living quarters for an assistant, and to do miscellaneous work in landscaping, transplanting trees, and planting for food and cover for wildlife.

#### SULLYS HILL GAME PRESERVE

Buffalo and elk are thriving on Sullys Hill Game Preserve, N. Dak., and under the surplus-disposal program, three buffalo and one elk were removed, the elk having been donated to a State park for exhibition purposes. Four deer died from a lung disease, and one from an injury. Beavers introduced in October 1935 are building dams, but it is not known whether they have increased.

About 60 acres of lake-bottom land were sown to tame hay, and from it about 50 tons of good forage were harvested and stacked during the summer of 1936. At the end of the fiscal year about 20 tons of hay had been stacked, with more to be put up later. It has not been necessary to purchase hay for the animals for several years.

Improvements, chiefly with W. P. A. labor, included construction in the buffalo and elk pasture of about 5 miles of road, most of which was graveled, fencing off a swampy corner of the deer pasture, building some small dams, placing a cattle guard at the front entrance, and completing a shop building.

The attractive recreational facilities available and the educational opportunities afforded in observing wildlife brought 17,621 visitors to the preserve during the year.

#### WICHITA MOUNTAINS WILDLIFE REFUGE

Fall rains in 1936 and nearly normal precipitation in 1937 counteracted a searing drought and greatly improved conditions on the Wichita Mountains Wildlife Refuge, Okla. Prospects for a fine mast crop were excellent, with acorns, pecans, and walnuts especially abundant, but browse and other range forage remained below par as a result of drought and some overgrazing by domestic stock.

Buffalo, elk, and Texas longhorns did well in the fenced pastures, and the calf crops were good, though not so large as in 1936. The large herd of buffalo cows and calves, sometimes more than 200 in a single band, could be seen from the main highway by the many thousands of visitors. During the year 37 buffalo, 14 elk, and 18 longhorn cattle, mostly culls and undesirables in the herd, were disposed of, and 10 elk were donated to the State Game and Fish Commission of Oklahoma to restock an area in McCurtain County. Deer have increased both inside and outside the refuge, some estimates placing the number at 3,000, including 680 within the refuge. A pet white-tailed doe that frequented the vicinity of headquarters and is known to have raised 27 fawns in 13 years died, but her descendants now constitute a sizable herd in that locality. Four antelope fawns, captured by refuge employees and several cooperators on the open range in Cimarron County, in the Oklahoma Panhandle, were brought to the refuge in an effort to form the nucleus of a new herd. The fawns are protected from predators in a 7-acre enclosure near headquarters.

A suspension of trapping privileges has resulted in an increase in the numbers of skunks, raccoons, rabbits, opossums, and other fur bearers. A gray fox, a rarity in this section, was captured on the refuge and released after examination. Wild turkeys and bobwhite quail show an encouraging increase, but the num-

bers of prairie chickens remain small. Though food and water were scarce over much of the Southwest it was estimated that during the winter 2,000 ducks occupied the refuge lakes at the height of the season. Crows became so numerous as to necessitate control measures, and 699 of these birds were trapped, as well as 98 coyotes.

Additional fingerlings were added to the lakes during the year by a shipment of about 30,000 from the Bureau of Fisheries station at Tishomingo and by a State donation exceeding that number from the hatchery at Medicine Park. Other game fish were introduced when lakes nearby were apparently drying up and when Lake Thomas was drained for repairs to the dam. Fish planted a year or two years ago are growing well, and the visitors enjoy feeding them from dams and lake shores.

The refuge has been carefully patrolled by the resident staff and by other Bureau employees temporarily detailed for the purpose. Motor-vehicle speeding was quickly curbed as the result of five arrests. A drastic curtailment in domestic-stock grazing will result in increased food and cover and prevent various forms of wildlife from seeking better forage outside, where they would be in danger from poachers. An effective deterrent to deer poaching, prevalent during the winter holiday season, was the arrest of one offender, who was given a 6-month jail sentence.

Increasing public use is being made of the 20,000-acre recreational section, largely by visitors from adjacent parts of Oklahoma and north Texas. Of the more than 325,000 visitors during the year, 40,000 came in 1 day to attend the annual Easter service and pageant conducted by local organizations. Bathing was a major attraction at nine lakes, thousands of picnickers enjoyed the public facilities at seven campgrounds, and outings were held by numerous civic and conservation organizations.

Extensive improvement programs were carried out by two C. C. C. camps and under four W. P. A. projects. The C. C. C. work included completion of a major campground unit (with bathhouses, community house, checking booth, caretaker's cottage, and attendant facilities), a 50-foot high concrete dam, and a group of structures for use in scientific research, as well as scores of smaller projects involving highway and bridge construction, trails, food and cover plantings, landscaping, earth-dam construction, erosion control, and provision of campground facilities.

Work on the Biological Survey's W. P. A. project for the reconstruction of a highway to the summit of Mount Scott is about 70 percent finished, the W. P. A. Easter-pageant development was completed in December, and the construction of a dam, sponsored by the town of Cooperton, was under way as the year closed. At Lake Thomas, which lies partly within the refuge boundaries, W. P. A. crews were engaged in final work on a huge earthen clay-core dam, which will form a lake of approximately 500 acres.

Valuable cooperation in the administration of the refuge was received from authorities at the adjacent Fort Sill Military Reservation and from the Bureau of Animal Industry. A specialist of that Bureau was called upon several times for advice when buffalo developed necrotic stomatitis, and also to inoculate longhorns during an outbreak of pinkeye among cattle grazing under permit.

#### CHARLES SHELDON ANTELOPE REFUGE AND RANGE

The antelope were late in returning to the summer range on the Charles Sheldon Antelope Refuge, Nev., last spring, but were in good condition when they arrived about the middle of April. There was a good crop of twin fawns, and when they began to follow their mothers late in May the herd made a fine appearance. A Federal trapper on the refuge killed several coyotes during the winter, but with the return of the antelope both coyotes and bobcats have again become overabundant. Mule deer are increasing in number and came through the winter in good shape. Sage grouse also are increasing on all the meadows, though their recovery is slow because of depredations on the young by hawks and owls, which nest on the refuge. Three handsome pinto ponies, a 2-year-old stallion and two brood mares, have been obtained for use in the administration of the refuge and also to perpetuate this breed so largely used as riding stock in the early days of the West. A cold, late spring and lack of spring rains retarded the growth of the grass and dried up all but the permanent springs, but there is apparently ample forage for all wildlife.

During the year E. C. W. workers constructed 10 miles of barbed-wire fence and completed 17 miles of telephone line, an overnight cabin, and work on 9 miles of new and 10 miles of rebuilt roads. Under regular appropriations springs have been developed and a tractor shed completed. For the protection of wildlife the range is regularly patrolled and efforts are made to keep the watering places in sanitary condition and predatory animals under control.

The Charles Sheldon Antelope Range of approximately 542,000 acres in Washoe and Humboldt Counties, Nev., was established by Executive order of December 21, 1936, and is to be administered under the Taylor Grazing Act of 1934 jointly by the Biological Survey and the Grazing Division of the Department of the Interior. It supplements the adjacent Charles Sheldon Antelope Refuge, embracing the winter range of the antelope herd that frequents summer ranges there. It also receives a considerable drift of antelope from the Hart Mountain Antelope Refuge, situated about 20 miles northwest, in Oregon. The Bureau has purchased about 17,000 acres of privately owned lands within the exterior boundaries of the range, primarily for use of the antelope, but has done no improvement work except to repair fences and irrigate the meadows.

#### HART MOUNTAIN ANTELOPE REFUGE

The Hart Mountain Antelope Refuge, Oreg., and the Charles Sheldon Antelope Range, Nev., contain lands first set apart by Executive order of September 6, 1935, as the Hart Mountain Game Range of 1,024,330 acres. This order was revoked on December 21, 1936, the area in Nevada defined in the original order was reestablished as the Charles Sheldon Antelope Range, and the Hart Mountain Antelope Refuge, with an area of 215,516 acres, was established in Lake County, Oreg. The designation of the Hart Mountain section as a refuge exclusively for the use of the antelope and other wildlife will afford the animals better protection than was provided under the original joint administration for grazing purposes. It will ultimately be enlarged by about 50,000 acres under plans to purchase privately owned lands within its exterior limits.

This refuge includes the fawning grounds and the summer range of the antelope, and to a large extent the winter range as well. With the nearby refuge and range in Nevada it forms a well-rounded project for the conservation and perpetuation of the antelope of the two States. The Hart Mountain Refuge furnishes also a much-needed haven for mule deer, sage grouse, and other wildlife.

A cold, dry, backward spring prevented normal forage growth on this refuge, and, though June rains improved conditions, water did not return to the long-dry lake beds and desert water holes as would be expected in ordinary seasons. There is promise, however, of a fair late growth of forage and consequent reseeded and revegetation. Reduction in the numbers of domestic stock permitted to graze on the refuge has been sufficient to make a greater growth of vegetation apparent, and a further reduction this fall will result in improved range conditions.

One law-enforcement case was brought to a satisfactory conclusion when the violator pleaded guilty to the possession of antelope and was fined and given a jail sentence, though half the fine and the jail sentence were suspended.

#### DESERT GAME RANGE

The Desert Game Range, Nevada, established by Executive order late in the last fiscal year, consists of 2,022,000 acres within the natural range of Nelson's mountain sheep, or desert bighorns. It is administered jointly by the Biological Survey and the Grazing Division of the Department of the Interior in connection with the organization of grazing districts for livestock under the Taylor Grazing Act of 1934. The Dixie National Forest is included in its southern part. Its high, narrow, desert mountain ranges once contained large bands of bighorns, but with unrestricted hunting, diseases contracted from the domestic sheep on their ranges, and depredations by predatory mammals and birds, especially upon lambs, the bighorns, in recent years, have just about held their own in some sections of their natural habitat and in others have become extinct. It is estimated that there are still about 150 on this range. Much of the Desert Game Range is barren, but under regulated grazing it should be possible to restore native forage, and, with the protection that will be afforded, the various forms of native wildlife should increase and thrive.

## FORT PECK GAME RANGE

The 970,000-acre Fort Peck Game Range, Montana, was established by Executive order of December 11, 1936, also under the Taylor Grazing Act of 1934, to be administered by the Biological Survey and the Grazing Division of the Department of the Interior. It includes lands extending through six counties now being acquired by the War Department for the construction of a 254-foot dam and reservoir on the Missouri River in a giant flood- and soil-erosion-control project. Mule deer occur throughout the range, as well as a few antelope and sharp-tailed grouse, and white-tailed deer inhabit the river bottoms. Waterfowl will find a resting place on the reservoir.

## NUNIVAK ISLAND WILDLIFE REFUGE

Nunivak Island Wildlife Refuge, in Bering Sea, Alaska, was originally reserved in 1929 as a preserve and breeding ground for native birds, wild game, and fur-bearing animals, and for use in conducting cross-breeding experiments with reindeer and native caribou. It is now serving also for experiments in the reestablishment of the musk ox in Alaska. Latest reports show approximately 5,000 reindeer on this island of about 1,111,000 acres, and experiments conducted in caribou cross-breeding have resulted in increased size and vigor of the offspring.

Four musk oxen from the herd received from Greenland in 1930 were transferred in 1935 from their range near Fairbanks to Nunivak Island, and in July 1936 the remaining 27 animals in the herd also were similarly transferred, by boat down the Yukon River to St. Michael, and thence by barge across about 300 miles of open water to Nunivak Island, where all arrived in fine condition. The herd has just about held its own during the 7 years it has been in Alaska, and now that all remaining of the original imports have reached breeding age and appear to be strong and virile, they should thrive and increase. The elimination of the predator menace, which had caused some losses, was one of the prime factors influencing the transfer of these valuable animals to the Nunivak Island Refuge, but there also they will find excellent range and adequate shelter from severe storms.

## WILDLIFE CONSERVATION LAWS ADMINISTERED

Federal statutes for the conservation and restoration of wildlife are administered by the Bureau of Biological Survey as follows: The Migratory Bird Treaty Act of 1918, protecting birds that migrate between the United States and Canada, as amended June 26, 1936, to extend its provisions to the treaty concluded March 15, 1937, protecting birds that migrate between the United States and Mexico and regulating the movement of game mammals and parts thereof between the two countries; the Migratory Bird Conservation Act of 1929, authorizing the establishment of bird refuges; the Migratory Bird Hunting Stamp Act of 1934, as amended June 15, 1935, to aid in refuge establishment; the Lacey Act of 1900, as amended June 15, 1935, regulating the shipment in interstate or foreign commerce of wild animals, their dead bodies, or parts thereof, and the importation of live birds and mammals from foreign countries; a law protecting wildlife and property on national wildlife refuges (sec. 84, Criminal Code); and, through the Alaska Game Commission, the Alaska game law of 1925.<sup>1</sup>

## REGULATORY ACTION

The regulations for 1936 under the Migratory Bird Treaty Act provided an open season on migratory waterfowl of 30 consecutive shooting days in each of three zones, instead of two zones as in the previous year—northern, intermediate, and southern. In the northern zone the season began on October 10, in the intermediate zone on November 1, and in the southern zone on November 26. Full protection was given three important species of waterfowl—the Atlantic coast brant, the redhead, and the canvasback duck, and similar protection was continued on snow geese in the States bordering on the Atlantic

<sup>1</sup> On June 17, 1937, a bill was introduced in the Senate to provide that the United States shall aid the States in wildlife-restoration projects, and it became law by approval of the President on September 2, 1937 (Public. No. 415, 75th Cong.).

Ocean, Ross's goose, wood duck, ruddy duck, bufflehead duck, and swans. The restrictions on taking waterfowl by means of bait or by the use of live decoys, and the three-shell limit on repeating shotguns also remained in effect. The regulation limiting waterfowl hunting to not farther from shore line or emergent vegetation than 100 feet was eliminated. The hours for shooting waterfowl and coots were, as previously, from 7 a. m. to 4 p. m., standard time, but Wilson's snipe was included with rails (other than coot), woodcock, mourning doves, and band-tailed pigeons, for which the shooting hours were from 7 a. m., standard time, to sunset. The daily bag and possession limits on migratory game birds were unchanged, but the interstate shipment of such birds was restricted to not more than 1 day's bag in a calendar week. While in a number of States the opening date for hunting mourning doves was September 1, the season in general was shortened 1 month.

The regulations for 1936<sup>2</sup> were published in the series of Service and Regulatory Announcements (BS-84), and the open season dates and other information regarding hunting were shown on a poster (No. 57-Bi). A migratory-waterfowl hunting-stamp poster also was issued. Other publications relating to conservation laws included the annual bulletin on Federal, State, and Provincial game laws (Farmers' Bulletin 1766); a mimeographed abstract of State fur laws affecting trapping seasons and possession, sale, and shipment of pelts (Leaflet BS-68); the annual directory of Federal, State, and Canadian game-protection officials (Miscellaneous Publication 244); and in the Department's Agricultural Statistics, 1937 (tables 542 and 543), hunters' licenses issued by States, with total money returns for the seasons 1934 and 1935, and sales of migratory-bird hunting stamps for the same years. Many press statements on wildlife-conservation subjects were issued for educational purposes and to advise the public of changes in the regulations, including those under the Alaska game law (Alaska Game Commission Circular 13).

The advisory board, Migratory Bird Treaty Act, an unofficial group of State game commissioners, naturalists, conservationists, and sportsmen, which for a number of years has furnished the Department information of a regional character as to the status of migratory waterfowl, was dissolved on May 26. Reorganization of the Bureau's advisory and cooperative system to meet current requirements on a more comprehensive scale is being effected.

#### WORK OF GAME-MANAGEMENT AGENTS

Under the supervision of regional directors, 36 United States game-management agents enforced the Federal game regulations in assigned districts, and during the hunting season were assisted by 23 deputy United States game-management agents, who operate in two- and four-man squads. Squad movements are directed by agents in charge of patrol districts, and these assistants were subject to immediate assignment in any part of the regions into which the country has been divided for facilitating field activities of the Bureau. All patrol units are equipped with fast automobiles, auto trailers, outboard motorboats, and speed launches. Seagoing cabin cruisers are in service on the east coast and in the Gulf of Mexico. Patrol officers wear uniforms of sand gray, of military design, trimmed in black. Shoulder emblems identify the officer as a Bureau employee and also indicate his regional assignment by number. In addition to the identifying uniform each agent is supplied with a distinctive badge and an identification card containing his photograph and signature. Uniforms are not worn during under-cover operations or during periods of intensive field campaigns.

Meetings of sportsmen, study groups, businessmen's organizations, and other public and private gatherings, and fairs are visited at various times by game agents in the interest of education in wildlife protection. Exhibits and illustrated talks play important parts in this program and tend to prevent violations of game regulations, thereby saving waterfowl for breeding purposes and reducing lawlessness. Recognition of the value of the new wild-fowl-protective measures is encouraging, and through the untiring efforts of the agents and cooperative State game officers many troublesome districts have been efficiently patrolled and violations reduced. This State cooperation has been of inestimable value and is highly appreciated.

<sup>2</sup> Regulations for the season 1937, adopted by the Secretary after the close of the fiscal year, were approved by the President on July 30, 1937 (2 F. R. 1615; S. R. A.-B. S. 88).

## HAZARDS OF THE WORK

Physical encounters in self-defense have been noticeably reduced following the Nation-wide publicity given to the death of Federal enforcement officers at the hands of game-law violators. Survey agents in three instances during the past year met with resistance in enforcing game regulations. In one case of armed resistance, which is pending final disposition, the violator was placed under \$3,000 bond pending trial. Three cases involving assaults on game-law enforcement officers were disposed of, one in Nebraska by fine of \$25, one in Iowa by directed verdict for the defendant, and one in Colorado by dismissal. One case is still pending. Hazards of drowning, accidental wounding by intoxicated gunners, and accidental injury through failure of equipment or other causes also are risked by the agents, and exposure in extremely cold temperature brought one agent to the hospital when ice conditions resulted in an unavoidable motor-vehicle accident.

## APPREHENSION OF VIOLATORS

There was a substantial increase of arrests and convictions. Duck bootleggers and sellers of illegal game, although still operating but on a reduced scale, have learned by severe penalties in the last 2 years that their enterprise is unprofitable. Agents and cooperators, in under-cover roles, have devoted many hours to investigating alleged duck sales. Night-club operators on the west coast suffered from inability to obtain ducks from their illegal shooters and bird runners by reason of the apprehension of waterfowl dealers who were detected in the act of transporting the contraband. The purchase by agents of migratory waterfowl at markets and eating places has become extremely difficult, for the illegal business has been harassed to the point that the prospective purchaser must be personally known to the bootlegger or bear a card of approval issued by the illicit dealer.

In 13 outstanding cases of killing or possessing ducks in close season, the defendants were assessed \$4,550 in fines in addition to jail sentences of 4 to 8 months. Not all these persons were sentenced to jail, but when the defendant was recognized as a previous offender, or it was proved that possession was a step toward effecting eventual illegal sale, the courts were firm in pronouncing sentence.

Lacey Act cases involving painstaking investigations over a long period were successfully prosecuted in 16 instances, and numerous defendants are involved in cases not yet terminated in several States. In 3,636 case investigations presented to various States for completion, the fines aggregated \$30,424. Not all the cases involved violations of the Lacey Act, but the evidence, as uncovered by Federal game-management agents, indicated State game-law violations that resulted in cooperative action with successful termination in State courts.

## VIOLATIONS AND PENALTIES IMPOSED

## MIGRATORY BIRD TREATY ACT CASES

Violations of the Migratory Bird Treaty Act reported by the Department for Federal prosecution showed an increase of 128 cases over the preceding fiscal year, and there were increases of 100 in the number of convictions and 101 in the number of cases disposed of (table 6).

TABLE 6.—*Cases of violation of the Migratory Bird Treaty Act disposed of during the fiscal year and cases still pending on June 30, 1937*

| Disposed of                 | Number | Pending                     | Number |
|-----------------------------|--------|-----------------------------|--------|
| Convictions.....            | 522    | From former year.....       | 1 447  |
| Dismissals.....             | 69     | New cases.....              | 610    |
| Verdicts of not guilty..... | 9      | Total.....                  | 1,057  |
| Adjudged not guilty.....    | 30     | Disposed of.....            | 733    |
| No bills found.....         | 25     | Pending at end of year..... | 324    |
| Stricken with leave.....    | 5      |                             |        |
| Nol-prossed.....            | 38     |                             |        |
| Prosecution abandoned.....  | 34     |                             |        |
| Closed by death.....        | 1      |                             |        |
| Total.....                  | 733    |                             |        |

<sup>1</sup> There were 539 new cases reported instead of the 482 stated in last year's tabulation, which added 57 to the 390 cases reported last year as still pending.

In 96 of the cases reported, prosecution was not recommended because of lack of evidence, youthfulness of the accused, or other satisfactory reasons. Fines ranging from \$1 to \$750 and costs aggregating \$11,428.21 were imposed in Federal courts. Six fines of \$25 each and one of \$50 were suspended. Verdicts of guilty were returned by juries in five cases. Jail sentences were imposed as follows: 1 day (2), 2 days (1), 3 days (1), 5 days (1), 12 days (1), 20 days (2), 30 days (11), 60 days (13), 3 months (4), 4 months (1), 5 months (1), 6 months (3), 8 months (1), an aggregate of 2,586 jail-days. Three jail sentences of 30 days, one of 3 months, and three of 6 months, totaling 720 days, were suspended. Sentence was suspended in 11 other cases. Defendants in 30 cases were placed on probation as follows: 1 for 30 days, 2 for 2 months, 1 for 3 months, 1 for 6 months, 15 for 1 year, 2 for 2 years, 1 for 3 years, and 7 for 5 years. Noteworthy cases were as follows:

Killing or possessing ducks in close season: California (2) \$500 and 6 months each, and (2) \$500 and 4 and 8 months each, respectively; Iowa (1) 21 days; Louisiana (2) 60 days each, (1) \$75; Maryland (3) \$50 each; Mississippi (1) \$750 and 6 months (failed to appear in court at time appointed); Nevada (1) \$100; New Mexico (1) \$50; North Carolina (1) 60 days; Tennessee (3) \$75 each.

Taking waterfowl by means of bait: Illinois (6) \$25 each, (8) \$10 each, (2) \$200 each; Maryland (1) \$25, (1) \$250, (2) \$10 each; Oregon (3) \$5 each, (3) \$100 each.

Selling ducks: Arkansas (1) 30 days; Illinois (1) (restaurant) \$75; Louisiana (8) 60 days each, (1) 90 days, and in 2 others a husband was given 60 days in jail and his wife placed on probation for 5 years; Maryland (2) \$500 each; Minnesota (1) 2 months.

Exceeding bag limit on ducks: California (1) \$170; Maine (1) \$100; Texas (2) \$50 each.

Using motorboat to concentrate ducks: Kansas (2) \$50 each.

Killing a canvasback duck: California (1) \$50.

Killing wood ducks: South Carolina (1) 90 days.

Killing ducks from motorboat: Maine (1) \$50.

Hunting coots in close season: Louisiana (1) 5 days, (2) 30 days each.

Killing doves in close season: Louisiana (1) \$50.

Taking doves by means of bait: Kentucky (2) \$10 each, (4) \$50 each.

Hunting doves with gun not properly plugged: Kentucky (3) \$36 each.

Hunting soras at night: North Carolina (6) 30 days each.

#### MIGRATORY BIRD CONSERVATION ACT CASES

Seven new cases involving violations of the Migratory Bird Conservation Act were submitted and three were pending from the previous year. Of these, 7 were closed—1 by a fine of \$10, 4 by probation for 1 year, 1 by a jail sentence of 30 days, and 1 by dismissal—and 3 are still pending.

#### MIGRATORY BIRD HUNTING STAMP ACT CASES

Violations of the Migratory Bird Hunting Stamp Act reported since this statute became effective total 218. In the preceding years 41 were closed and the new cases submitted totaled 97. Of this year's pending and new cases, 74 were successfully concluded, 67 by fines of \$1 to \$25, aggregating \$442, and 7 as follows: Suspended sentences for 5 years (2), probation for 1 year (2), probation for 2 months (2), and probation for 3 months (1). Twenty-nine other cases were disposed of as follows: Not-prossed (3), dismissed (10), closed without prosecution (9), no bill (3), not guilty (4). Of 6 other cases, closed the preceding year but not reported for inclusion at that time, 1 was dismissed and 5 were closed without prosecution. Cases still pending total 68. Fines and costs imposed since the passage of the act have aggregated \$1,437.

#### WILDLIFE REFUGE TRESPASS CASES

Four new cases under the law protecting wildlife and Government property on national wildlife refuges were reported and 4 were pending from the previous year. Of the 8, 5 were closed—2 in Arkansas, 1 in New Jersey, and 1 in North Carolina, by fines aggregating \$70, and 1 in Oklahoma by a 6-month jail sentence—and 3 are still pending.

#### LACEY ACT CASES

Sixteen new cases under the Lacey Act were reported in the following States: Montana (2) and Ohio (1), involving the illegal interstate transportation of deer; Michigan (6), illegal interstate transportation of skins of fur animals; Texas (1), unlawful interstate shipment of live birds not properly marked; Maryland (2), unlawful shipping of ducks and quail and also mismarking of

packages; and Missouri (4), unlawfully transporting beaver skins. The Texas case was closed by a fine of \$100 on the first count and a fine of \$100 and 6 months in jail on the second count, which latter fine and sentence were suspended and the defendant placed on probation. The 6 Michigan cases were closed by jail sentences of 18 months (1), 13 months (2), 8 months (2), and 6 months (1): the 2 Maryland cases, which also involved the sale of ducks, by fines of \$500 each and costs.

Information relating to infractions of State game laws was discovered by game agents operating under this statute as a result of inspections at fur-receiving centers in 21 States. Data relating to 2,626 apparently illegal shipments of skins of fur animals were furnished to game-protection officials in 39 States, Alaska, and Canada. In 18 States, 168 cases based on information originally furnished by the Bureau were closed by fines and costs of \$3,424, and in 8 of these States jail sentences of 10 to 30 days were imposed in 15 cases. In 1,284 other investigations reported on by the States it was determined that shipments had been lawfully made, and in 117 others that prosecution would be inadvisable.

Evidence regarding 1,011 cases involving violations other than illegal interstate shipments of skins of fur animals were submitted to the game departments of 42 States. Fines and costs accruing to the States amounted to \$27,000. In addition, in 28 cases jail sentences ranging from 1 to 60 days were imposed. Defendants were dismissed in 21 cases.

#### COURT ACTION ON THE BAITING REGULATION

Two cases involving the hunting of wild ducks by means of bait, wherein the defendants had entered pleas of not guilty, were concluded in Federal Court for the Southern District of Illinois in February, by fines of \$200 and costs of \$50 each. An appeal from the decision was taken.

A bill by certain hunting clubs was filed in the southern district of California during October to enjoin enforcement of the Migratory Bird Treaty Act regulations, charging that the treaty did not authorize Congress to give the Secretary of Agriculture power to regulate the means by which migratory birds could be taken. The temporary restraining order was in effect a few days, but the court promptly rendered a decision (which was appealed) by which the order was dissolved and the action dismissed, stating in its opinion:

It would seem, in view of the conditions of the treaty, that it is contemplated that the United States may restrict the taking of edible wild fowl through certain specified periods of time and may create closed seasons when such game may not be taken at all. It appears logical that where an open season is provided, the qualification be imposed as a condition that during such open season baiting or luring of the wild fowl should not be permitted, because plainly that would result in a greater number being collected together and captured. The regulation referred to applies generally to all sections of the United States.

#### WILDLIFE CONSERVATION IN ALASKA

##### LAW ENFORCEMENT

Several changes were made in the regulations for the 1937-38 hunting and trapping season prescribed by regulations under the Alaska Game Law. An open season on beavers was provided throughout most of Alaska for the spring of 1938, with a seasonal bag limit of 10. Minor changes were made in the opening and closing dates of the open seasons on other fur animals, and the Kenai Peninsula west of the Alaska Railroad was closed to the trapping of minks, martens, land otters, weasels, foxes, and lynxes. The Commission, by a slight increase in the appropriation, was able to maintain 11 full-time game wardens in the field during the year, as against 8 for the previous year, though that number is insufficient for adequate patrol of Alaska's total area of 590,000 square miles and its 35,000 miles of irregular coast line.

During its twelfth operating year in Alaska, the Alaska Game Commission has received excellent support from local residents, members of the Territorial Legislature, and other officials. Regulations recommended by the Commission and enforced by the wardens have been changed only after careful study of the conditions under which many people in outlying districts in the Territory must live. The importance of fur animals to the Territory's 30,000 native Indians, Eskimos, and Aleuts, besides several hundred white trappers, is realized, as is the value of Alaska's big game as an attraction to nonresident hunters, who spend hundreds of dollars annually in their shooting and photographic expeditions into the Territory.

## WILDLIFE RESTOCKING PROJECTS

The only restocking work accomplished in Alaska during the year was the transplanting of 27 musk oxen from the Bureau's experimental station at Fairbanks to Nunivak Island in Bearing Sea, already mentioned (p. 51). The 8 elk transported to Afognak Island 8 years ago have increased to a herd of nearly 100, and the original herd of 23 buffalo placed in the Big Delta section near Fairbanks has increased to approximately 140. Neither the elk nor the buffalo have required artificial feeding. The 558 snowshoe rabbits transplanted from the Alaska Railroad belt in 1934 to Kodiak Island, with funds provided by the Civil Works Administration, have now become thoroughly established. Numerous other transplantings made in past years, involving mountain goats, black-tailed deer, beavers, muskrats, martens, squirrels, marmots, and ring-necked pheasants, show promise of success.

## PREDATORY-ANIMAL CONTROL

Despite the Territorial bounty of \$20 each on wolves and coyotes, damage by these predators has continued to such an extent that the Territorial Legislature appropriated further funds for a cooperative program with the Bureau of Biological Survey to employ expert trappers to demonstrate control methods. The greatest damage appeared to be centered among the reindeer herds of the Arctic coast.

## IMPORTATION AND OTHER PERMITS ISSUED

## FOREIGN SPECIES EXCLUDED

Several unsuccessful efforts were made during the year to import bullfinches and other species of birds excluded from this country by order of the Secretary of Agriculture of December 26, 1935, and by subsequent Treasury Department regulation, and it is again pleasing to report that no forbidden species of bird or mammal has established a foothold in the United States since 1900, the year in which the law regulating importations of wild birds and other animals became effective.

Incident to the going into effect on March 15, 1937, of the convention between the United States and Mexico for the protection of birds migrating between the two countries, it became necessary to refuse permits to import, usually from Cuba and Mexico, certain species except by museums and other scientific institutions and by individuals holding scientific possession permits from the Department. By virtue of the Mexican treaty there is prospect of early suppression of the cage-bird traffic in a number of kinds of song and insectivorous birds, including painted buntings, indigo buntings, goldfinches, and orioles, which have heretofore been captured in Cuba and Mexico and freely commercialized in those countries and exported to this country for similar purposes. These species are also captured to a considerable extent in some of the Southern States and thus introduced into the cage-bird traffic. It is gratifying to report that the Department's action with reference to the capture and commercialization of these migratory birds has already stimulated some of the State conservation departments to action of a similar nature under the powers conferred upon them by their conservation laws. Prior to the Mexican convention, these species were not within the scope of general Federal protection and therefore were admissible as imports.

Eight flying foxes (*Pteropus personatus*) that arrived in a shipment from India on August 28 were not only refused entry but were killed by the customs officials at the dock. The dead bodies, however, were permitted to be delivered to the Staten Island Zoological Society for scientific research work. About September 4, two meercats (*Cynictis penicillata*) arrived at New York on a steamer from South Africa and also were killed by the customs officials. One crested myna (*Aethiopsar cristatellus*) was refused entry at San Francisco, and two bullfinches (*Pyrrhula pyrrhula*) and two European yellowhammers (*Emberiza citrinella*), discovered in a shipment of canaries arriving at New York last October, also were excluded.

Four goldfinches, one of which had died from suffocation, were seized on May 14 by a customs guard at New York from a member of the crew of a large ocean passenger vessel. The would-be smuggler had tied the birds around his ankles inside his socks. Before the legal division of the Customs Service he was fined \$45 and warned that the next offense would bring a heavier penalty.

## SPECIES ENTERED UNDER PERMIT

1937

## BIRDS

There were 1,590 permits issued during the year, including 56 at Honolulu, Hawaii, for the importation of foreign birds and mammals, and 278 importations were inspected. A total of 300,817 foreign birds were imported into continental United States as compared with 230,140 last year, including 162,700 canaries, 3,765 parrots, 101,396 Mexican quail, 3,482 Hungarian partridges, 1,420 pheasants, and 28,054 miscellaneous birds, the increase over the preceding year being especially notable in the numbers of parrots and bobwhite quail. At Honolulu, Hawaii, 2,337 foreign birds were entered, and at San Juan, Puerto Rico, 84.

Entries of Hungarian partridges from Canada diminished considerably, but several large shipments of these birds were imported from Europe, all for propagation in Pennsylvania. Many other species of partridges were imported from India and the Orient, including 20 spectacled partridges (*Francolinus* sp.) from Singapore, Straits Settlement, and 1 black partridge (*F. francolinus*) and 2 rock partridges (*Ammopercidia griseogularis*) from India.

Pheasants in great variety were imported, including 4 white-crowned Kaleege pheasants (*Gennaeus leucomelanus hamiltonii*), 8 Nepal Kaleege pheasants, (*G. leucomelanus*), 9 Impeyan pheasants (*Lophophorus impejanus*), 21 monal pheasants (*L. sclateri*), 4 Rheinhardt's pheasants (*Rheinardia ocellata*), and 4 koklass pheasants (*Pucrasia* sp.), from India; 7 Cabot's tragopans (*Tragopan caboti*), 4 Elliot's pheasants (*Calophaps ellioti*), 4 Reeves's pheasants (*Syrnaticus reevesii*), and 4 Manchurian eared pheasants (*Crossoptilon manchuricum*), from China; 4 Swinhoe pheasants (*Microphaps swinhoei*), 7 fire-backed pheasants (*Lophura rufa*), 4 Siamese firebacks (*Diardigallus diardi*), and 3 versicolor pheasants (*Phasianus colchicus versicolor*), from Japan; and 1 argus pheasant (*Argusianus argus*), from Singapore.

Quarantine restrictions were maintained by the Public Health Service on the importation of birds of the parrot family, and no new outbreaks of psittacosis were reported, despite a substantial increase in the number of parrots entered during the year. Among these parrots were 2 red-faced lovebirds (*Agapornis pullaria*) and 5 gray parrots (*Psittacus erithacus*), from Africa; 50 chocolate coumres (*Aratinga pertinax aeruginosa*), from Colombia; and 1 dwarf macaw (*Ara maracana*), from the Canal Zone.

Other interesting importations were 25 crowned finches (*Coryphospingus pileatus*) and 10 archbishop tanagers (*Thraupis ornata*), from Venezuela; 11 mockingbirds (*Mimus gilvus melanopterus*), 12 Colombian quail (*Odonotophorus atrifrons*), and 7 Colombian rails (*Aramidus c. cajanea*), from Colombia; 1 yellow-bellied blackbird (*Pseudoleistes virescens*), 6 spectacled ibises (*Theristicus caudatus*), and 6 horned screamers (*Palamedea cornuta*), from Brazil; 4 Bonaparte's tawny robins (*Turdus grayi casius*), 3 Panamanian woodpeckers (*Centurus sublegans wagleri*), 4 Cassin's doves (*Leptotilia cassini*), and 2 stripe-breasted saltators (*Saltator albicollis*), from the Canal Zone; 1 sickle-billed bird of paradise (*Falcinellus meyeri*) from New Guinea; 1 black tanager (*Tachyphonus rufus*), from Trinidad; 1 black-naped oriole (*Oriolus indicus*), from Celebes Island; 2 Laysan albatrosses (*Diomedea immutabilis*), from Midway Island; 2 broad-billed weavers (*Amblyospiza albifrons*), 1 imperial ant pitta (*Grallaria imperator*), and 10 queen wydahs (*Tetranura regia*), from Africa; 5 satin bower birds (*Ptilonorhynchus violaceus*), 1 red-tailed oriole (*Oriolus trailii*), 1 tree pie (*Dendrocitta rufa*), 2 pearl turtle doves (*Spilopelia chinensis*), and 30 Chilean flamingos (*Phoenicopterus ruber chilensis*), from India; 13 plum finches (*Aidemosyne modesta*), from Australia; 1 jay thrush (*Dryonastes chinensis*), from China; 1 Japanese warbler (*Horornis cantans*) and 4 Mongolian larks (*Mcclanocorypha mongolica*), from Japan; 1 helmet-crested hummingbird (*Orthorhynchus exilis*) and 1 ruby topaz hummingbird (*Chrysotamias elatus*), from Central America.

Bobwhites imported from Mexico aggregated 101,396, the largest number for a single year since 1900, when importations were first subjected to Federal permit. The special regulations governing the importation of bobwhites from Mexico, in effect since December 1927, were amended on October 23, by adding Nogales, Ariz., to the ports of entry and by changing the importation season to conform with the Mexican exporting season of 4 months, from November to March. The quails imported were distributed to the following States: Mississippi, 40,676; Indiana, 24,831; Texas, 15,543; West Virginia, 6,669; Kentucky,

5,768; Florida, 2,136; South Carolina, 846; Tennessee, 753; Virginia, 425; North Carolina, 341; Pennsylvania, 249; Alabama, 200; Iowa, 175; New York, 174; Oklahoma, 163; Illinois, 154; and the rest in small lots of less than 100 each to several other States, and 200 to Hawaii.

#### MAMMALS

Continued interest was manifest in the importation of black bear cubs from Canada, the number imported being 113, as compared with last year's 102. These cubs are used principally for exhibition at amusement parks and roadside menageries and stands. Due to the fact that several children and other persons had been seriously injured by bears kept in captivity, New York now requires a State license for the entry of these mammals and for keeping them in captivity. Federal permits, therefore, are not issued for importations destined to New York State unless the importer forwards a copy of his State license with his application. A few Russian brown bears and polar bears also were imported.

Importations of monkeys included one gorilla and several baboons, chimpanzees, mangabeys, drills, mandrills, hussar or military monkeys, and pig-tailed monkeys, from Africa; Makassar black monkeys, from India; orangutans, gibbons, and langur monkeys, from Singapore; macaques, from Java and the Philippines; and marmosets, ringtails, spider monkeys, moss monkeys, woolly monkeys, capuchins, owl monkeys, sapajous, and saki monkeys from Central America and South America. The total number of the popular rhesus monkeys imported during the year was 12,421.

A considerable number of South American animals were brought in by passengers for pets, including coatimundis, honey bears, kinkajous, agoutis, and pacas. Among the more interesting mammals imported were 1 giant panda (*Ailuropoda melanoleuca*) from Shanghai, China, captured near the Tibetan border, about 2,000 miles from Shanghai, when it was about a week old; 8 tricolor squirrels (*Sciurus ruffalii*), from Singapore; 2 giant gray kangaroos (*Macropus giganteus*), 2 Bennet's kangaroos (*M. bennetti*), 2 dorsalis kangaroos (*M. dorsalis*), and 1 wallaroo (*M. robustus*), from Australia; 2 Tasmanian devils (*Sarcophilus ursinus*), from India; 1 palm cat (*Nandina binotata*), 6 Turkestan porcupines (*Hystrix hirsutirostris*), 2 crested porcupines (*H. cristata*), 1 ratel (*Mellivora ratel*), and 1 bush pig (*Orycteropus apa*), from Africa; 1 crab-eating raccoon (*Procyon cancrivorus*), from Colombia; and 10 giant anteaters (*Myrmecophaga jubata*) and 9 maras (*Dolichotis patagonica*) from Brazil.

Seventy-six chinchillas were imported from Chile after a lapse of several years during which many attempts were made to obtain some of these valuable little fur-bearing animals. Chile and other South American countries stringently protect chinchillas by law and require special exportation permits. Before permits to import chinchillas into the United States will be issued, therefore, applicants must forward to the Department a copy of their export permits. Of the chinchillas imported, 71 were shipped to California and 5 to Missouri.

#### PERMITS UNDER THE MIGRATORY BIRD TREATY ACT

##### FOR SCIENTIFIC PURPOSES

Under the new policy effective July 1, 1936, the Bureau discontinued the issuance of annual permits to take migratory birds and their eggs for scientific purposes, and substituted conditional permits without time limitation but subject to revocation at the discretion of the Secretary and to forfeiture for violation of Federal or State conservation laws. During the year, 1,721 of these conditional permits were issued, 2 of which were canceled, leaving 1,719 outstanding at the close of the year.

All outstanding permits to possess, buy, sell, exchange, and transport migratory birds and their eggs were recalled during the year for elimination of the privileges of purchasing and selling specimens. At the close of the year, 303 of these revised permits were outstanding. For possessing one or more specimens found dead and salvaged, 226 permits were issued. Permits were issued to 215 persons to take migratory birds for banding.

## FOR WATERFOWL PROPAGATION

During the year 21 permits were issued authorizing the taking of migratory waterfowl for propagation, each permit limiting the species and number of each to be taken and the time for taking them, and 289 to possess such waterfowl. With 415 permits surrendered, canceled, or revoked, 3,986 were outstanding at the close of the year.

Reports submitted by permittees disclose that 3,673 wild geese and 55,781 wild ducks were raised in captivity. Of the latter 50,622 were mallards, 3,870 black ducks, and the remainder principally wood ducks, teals, ringnecks, wigeons, pintails, and redheads. Sales of propagated migratory waterfowl for food included 16,122 ducks and 391 geese; and for propagation, 9,236 ducks and 1,334 geese. Of propagated birds, 12,017 ducks and 222 geese were released for return to the wild state.

## PERMITS FOR SPECIAL USES OF REFUGES

For grazing, hay harvesting, and other uses on national wildlife refuges, including the big-game preserves, 227 special-use permits, some requiring the payment of a fee, were issued, exclusive of permits issued by the supervisory officers of the Wichita Mountains, the Upper Mississippi River, and the Aleutian Islands Refuges. The revenue derived aggregated \$26,622.75.

## COOPERATIVE CONTROL OF PREDATORY AND OTHER INJURIOUS ANIMALS

The year's operations in predator and rodent control involved expenditures of \$594,531 from regular departmental appropriations, supplemented by \$382,673 by cooperating States, and \$903,919 by cooperating counties, livestock associations, and others, and about \$1,125,800 of emergency funds on work under Biological Survey supervision. Predators taken through this cooperation, which aggregated 89,289 and exceeded last year's records by 16,162, consisted of 80,299 coyotes, 1,007 wolves, 7,471 bobcats and lynxes, 1 ocelot, 299 bears, and 212 mountain lions. Rodent control involved the treatment of 34,652,418 acres infested with prairie dogs, ground squirrels, pocket gophers, jack rabbits, porcupines, field mice, cotton rats, kangaroo rats, and woodchucks. In addition 213,619 premises were treated in cooperative campaigns for the control of common brown rats. Predator-control activities were extended to the Territory of Alaska.

Publications issued during the year on control procedure and matters related to control operations included Circular No. 423, The House Rat, and Farmers' Bulletin No. 1768, Trapping and Transplanting Live Beavers, and the following mimeographed leaflets: Rodent Control Aided by Emergency Conservation Work (BS-54, revised with illustrations), Suggestions on Trapping Coyotes and Wolves in Alaska (BS-62), and Directions for Destroying House Mice (BS 78).

## PREDATORY ANIMALS

The continued increase of predators, especially coyotes, over wide areas of the Western States, principally west of the one hundredth meridian, has aroused added interest in their control on the part of cooperating organizations, and State legislatures in Texas, Oregon, Oklahoma, Colorado, and Idaho have substantially increased their appropriations for cooperative work with the Bureau. State funds were thus increased from \$75,000 to \$100,000 in Texas, from \$16,000 to \$28,000 in Oregon, and from \$6,500 to \$15,000 in Oklahoma. The Colorado Legislature increased the levy from 4 to 6 mills on assessed valuations of stock sheep and goats and in addition appropriated \$7,500; the Idaho Legislature increased the levy from 5 to 10 mills on assessed valuations of sheep. Other cooperators, including counties, livestock associations, predatory-animal clubs, and individuals, expended additional funds for the protection of livestock from depredations by stock killers.

## WOLVES AND COYOTES IN ALASKA

Early in the year predator-control work was resumed in Alaska in cooperation with the reindeer service and the Office of Indian Affairs of the Department of

the Interior, by the assignment of a district agent of the Survey to the Territory for the purpose of investigating depredations of wolves and coyotes, particularly to reindeer and game species. The Territorial Legislature later appropriated \$15,000 for the employment of demonstration trappers and the purchase of supplies. Efforts are being expended to familiarize native trappers with methods of taking the larger predators and in making it possible for them to obtain necessary equipment. The reindeer, herded formerly by constant attendants, have been allowed, during recent years, to roam more or less and now are corralled only at certain seasons. This change in herd management has caused the reindeer to scatter widely over the ranges and has made it possible for the increasing numbers of wolves and coyotes to make greater inroads on the herds. An outstanding example is furnished by a reindeer company near Skungnak, which reported its herd nearly wiped out by predators; whereas in 1935 it had an actual count of 3,000 head, in December 1936 it could gather only 650, with a possibly equal number somewhere on the range. Investigations have shown wolves to be present in the immediate vicinity of both reindeer and caribou herds. Licensed hunters and trappers reported to the Alaska Game Commission the taking of only 514 wolves and coyotes during the fiscal year 1930 but a steady increase from year to year, until in 1936 the total was 1,236. These figures do not represent all wolves and coyotes taken in Alaska, but they do give an indication of the alarming rate at which these predators are increasing.

#### PREDATORS IN ALABAMA

An expert predatory-animal hunter was assigned to work in Alabama, where wolves and coyotes were destroying livestock and poultry, and on a relatively small area, he reported taking nine wolves and one coyote. Removing these animals materially lessened the losses among the livestock and poultry in the State. Investigations also were made looking toward the control of bobcats and foxes on national forests in Georgia and Tennessee, where these predators have become so abundant as to warrant control for the protection of game.

#### EMERGENCY PROGRAM IN PREDATOR CONTROL

Through the medium of the W. P. A. in cooperation with various State organizations and departments, predatory-animal control operations were conducted in Utah, Idaho, Wyoming, Montana, and Oregon. These projects supplemented other control work and made it possible to give livestock and game some degree of protection from predators on areas where protection would otherwise have been impossible through regular channels.

#### RODENT CONTROL

##### RATS IN HAWAII

Early in the year a district agent was assigned to Hawaii to correlate rat-control projects in cooperation with the University of Hawaii, through its agricultural experiment station and extension service, and the Territorial Board of Health. Financed largely by Agricultural Adjustment Administration funds, the control work was inaugurated for the protection of pineapple, sugarcane, coffee, and macadamia nuts from rat depredations and for the improvement of health conditions within the Territory, especially on two specific areas where bubonic plague is present. Typhus fever and trichinosis also are present on certain islands, and rat carriers are responsible to a certain extent for the prevalence of these diseases. On certain pineapple plantations on the island of Lanai, the common brown, or Norway, rats had become so abundant that they damaged as high as 60 percent of the pineapple fruits. On sugarcane areas experimental analysis for sugar content and counts of damaged cane indicated that on a single plantation of 17,000 acres rats were responsible for a direct annual loss in sugar of about \$147,000. Rat damage is also a serious factor in the Kona coffee-growing section, where the rodents nip off branches that ordinarily bear coffee berries for a 2-year period. This damage on certain plantations amounted to 10 to 15 percent of the crop. Application of control methods has materially lessened the losses.

Research in connection with the rat-control project in Hawaii was conducted for developing more efficient baits and improving and developing specific procedure in field application. Considerable improvement in bait material and in methods of distribution was made in the infested pineapple, coffee, and maca-

damia nut areas, but the methods of procedure in the sugarcane areas need further development and refinement. A laboratory and bait-production plant has been established at Honolulu for experimenting with rat-control baits and for preparing them for shipment to the various islands of the Hawaiian group. Means of canning perishable rat baits have been perfected so that they can be shipped as needed.

#### EMERGENCY RODENT-CONTROL PROGRAMS

Cooperative rodent control was conducted during the year through the medium of the Emergency Conservation Work, Works Progress, Agricultural Adjustment, Resettlement, and Emergency Relief Administrations. The Emergency Conservation Work projects were conducted cooperatively with the Forest Service and the Soil Conservation Service of the Department of Agriculture and with the Division of Grazing, Bureau of Reclamation, and Office of Indian Affairs of the Department of the Interior. All work was supervised by the Biological Survey and by field workers specifically trained by the Bureau in systematic rodent-control operations. Work was undertaken only where a specific need for the control of rodent pests was evident and where such control would lead to the future restoration and development of wide areas of grazing lands and for the protection of irrigation projects, agricultural crops, forest trees, and horticulture.

In California 75 percent of all structural failures of ditches, contours, and terraces constructed under soil conservation programs have been traced to the activities of pocket gophers. Throughout the farm-forestry project areas within the Dakotas, Nebraska, Kansas, Oklahoma, and Texas, it was necessary to maintain a vigilant control program to prevent young tree plantings from being destroyed by rodents, especially by jack rabbits.

#### RODENTS AND SYLVATIC PLAGUE

The Public Health Service has reported the presence of sylvatic plague among native rodents in additional localities during the year, showing a further spread of this epizootic. Measures for the control of rodent carriers at plague foci have been continued in California, Idaho, and Montana and have been extended in Oregon and inaugurated in Nevada and Utah. The existence of sylvatic plague among native rodents in the Western States continues to present a serious situation.

In California the plague was found only in the coastal sections until 1934, when it was recognized as the cause of increased mortality among ground squirrels (*Citellus beecheyi*) in interior counties. Later, dead and dying Oregon ground squirrels (*C. oregonus*) in Modoc County, in the northeastern corner of California, were found to be infested with plague, and in May 1934 a sheep herder employed on the desert near Lakeview, Oreg., died of the disease, the bubonic form in man. The United States Public Health Service found that the Oregon Columbian ground squirrels (*C. columbianus*) in Lake, Grant, and Wallowa Counties, Oreg., were carriers of the plague. Later it was discovered among Richardson's ground squirrels (*C. richardsonii*) in Beaverhead County, Mont., and in the same vicinity both fleas and lice taken from a golden-mantled marmot (*Marmota flaviventris nosophora*) proved positive for plague, the first American record that these rodents could carry the disease.

In May 1936, sylvatic plague was discovered in fleas taken from the Nevada ground squirrel (*Citellus richardsonii nevadensis*) near Elko, Nev. It had previously occurred among rodents in the Lake Tahoe section. In July 1936, public-health authorities found plague among the Uinta ground squirrels (*C. armatus*) in Bonneville County, Idaho. In August 1936, a boy in Beaver County, Utah, bitten by a wounded rock squirrel that he had picked up, contracted bubonic plague. At that time ground squirrels, prairie dogs, and jack rabbits were reported to be dying in that vicinity from some unknown cause. Authorities of the United States Public Health Service, conducting an investigation, found that the disease was carried by a marmot (*Marmota engelhardti*), the Utah prairie dog (*Cynomys parvidens*), and rock squirrels (*Citellus grammurus*). Previously it had been discovered in California that the wood rat (*Neotoma ciueca*), the Sierra chickaree (*Sciurus douglasii*), and the white-footed mouse (*Peromyscus*) could transmit the infection. Thus it is seen that at least eight species of squirrels, as well as wood rats, mice, marmots, and prairie dogs, are victims of sylvatic plague.

The constantly increasing list of rodents that may serve as hosts for the disease-carrying fleas arouses speculation as to the present status of sylvatic plague. That rodents fluctuate in numbers in a particular locality has long been a familiar observation. Climatic conditions together with increased food supplies resulting from the extension of irrigation and the cultivation of many western valleys have favored the reproduction of native rodents. Outbreaks of plague among rodents have often been recorded, and since the discovery of tularemia in southern California in 1911, the decimation of rodent population has been commonly attributed to this disease. The widespread occurrences of sylvatic plague that have been noted since public-health authorities have increased the scope of their examinations of squirrels and other suspected plague carriers now suggest that many of the epizootics among wild rodents might have been caused by sylvatic plague rather than by tularemia. The recent discovery of plague over such widely separated areas may not be due so much to a spread of the disease among rodents as to the development of more intensive investigations and refinement of technique: it is possible that the disease may have been present but unrecognized for many years. Every effort to prevent its further spread is imperative.

#### SUPPLY DEPOT AND LABORATORY

Congressional legislation at the close of the preceding fiscal year, authorizing the establishment of a game-management supply depot and laboratory, made it possible for the Bureau to purchase in April a tract of land in Pocatello, Idaho, including a structure thereon that formerly had been rented as a bait-mixing station. Arrangements are now being made for the construction of an extension to the present building to facilitate the storage and handling of miscellaneous supplies, for use in various field activities of the Bureau.

In cooperation with the Pocatello (Idaho) Chamber of Commerce, the supply depot has prepared scientifically treated baits for distribution to cooperators throughout the United States. This year's production totaled 2,180,021 pounds, an increased output sent primarily to cooperators for the control of rodents on privately owned lands.

In addition to the preparation of bait materials the supply depot has distributed quantities of bait-mixing ingredients, ammunition, refrigerators, water heaters, ranges, and other miscellaneous official equipment. One carload of predatory-animal traps was also distributed to cooperators. Production there of standard adjustable pocket-gopher probes has materially assisted cooperative control projects in the several States.

#### CONTROL METHODS RESEARCH

The Control Methods Research Laboratory at Denver, Colo., has made progress during the year along several lines of investigation. Outstanding studies were concerned with lethal doses of bait material for birds and mammals, developing fumigants, control of mice in orchards, control of rats, control of rodents in relation to range and to forest regeneration, and the migration of coyotes. Circular No. 409, on The Effect of Thallium on Plant Growth, was issued, showing lack of harmful effects on vegetation following field operations; and a leaflet (BS-91) described Research Studies in the Control of Destructive Mammals.

#### LETHAL DOSES FOR BAIT MATERIAL

Studies of the effect of strychnine alkaloid on horses, Canada geese, mallard ducks, Chinese pheasants, Hungarian partridges, and the Oregon ground squirrel have been made to determine the quantity required for lethal doses. It was found that susceptibility of birds to strychnine varied greatly and that the horse is considerably more susceptible than other domestic livestock studied. These studies, however, revealed that when the recommended standard field practices are followed, the Biological Survey formulas for rodent control are noninjurious to game birds and domestic stock.

#### BURROW FUMIGANTS

Further experiments were made with poison-gas pyrotechnic cartridges for fumigating rodent burrows. It has been found that the cartridges as now developed burn well and are convenient to handle in the field but that the warn-

ing factor to rodents in the burrow is still too high and the toxicity of the gas or gasses apparently too low. The variability of soil type, temperature, and moisture make it imperative that a successful rodent-control fumigant be effective over the widest possible range of these factors. Further investigations on this line are essential.

#### ORCHARD-MOUSE CONTROL

To study the problem of mouse control in New England orchards, a field investigator was assigned to the region in September. It has been found that mice (*Microtus*) quickly detect the presence of strychnine incorporated in a bait material and that they will eat the bait sparingly until a large percentage is consumed without harm. Apples cut into quarter-inch cubes are best accepted, except where windfall apples are available.

During the winter of 1936-37, mouse damage to orchards in New England was of an unusual nature, because of an extremely mild season and an absence of snow covering. Under these conditions it was found that, instead of girdling the trees above the ground, under cover of snow, the mice tunneled underneath the surface to the roots and then along the roots to the root crown, girdling it and thus killing many trees. In one 5-acre, 12- to 15-year-old orchard, 90 percent of the trees had been entirely girdled by mice. In another orchard of 7,000 trees, 25 to 35 percent were damaged by mice during the winter, even though the orchardist had so placed mounds of cinders as to give the mice no opportunity of girdling the trees above the ground.

In Connecticut, 350 to 400 apple trees were girdled by pine mice in a 12-year-old orchard, the first time the pine mouse (*Pitymys*) has been found to be present in the State. So far as known, however, it has not as yet extended northward to the other New England States. Orchardists in this locality had not been aware of what the mice were doing until the matter was called to their attention by the field investigator. Progress has been made in developing practical methods of mouse control in this section and in impressing upon the orchardists the necessity of proper application of control methods.

#### IMPROVED RAT BAITS

Progress has been made in the development of a permanent rat-control bait for use in and about buildings, and the results obtained in three cities are encouraging.

#### RODENTS AND RANGE AND FOREST REGENERATION

Continued studies looking toward the control of rodent pests, especially mice, in their relation to the regeneration of Douglas fir, Sitka spruce, and western hemlock in Washington and California, have developed effective bait materials and field procedure. Pocket gopher plots on the Ochoco National Forest, Oreg., have been continued, where studies have been made relative to damage by these rodents to grazing areas. These plots are showing the heavy damage by pocket gophers to the range and that some grazing of livestock aids in keeping the range in better condition where pocket gophers are present.

#### COYOTE MIGRATION

Studies have been continued on the migration of coyotes in western livestock range areas. Several young coyotes have been tagged and released on summer and winter grazing areas in order to learn about their migrations from their native localities. Interesting and valuable information for use in the control of this mammal is expected from this experiment.

